QTC

Messages and news from RASA

The Radio Amateur Society of Australia

September/October 2020

INSIDE:

Protecting your antennas

Updates on regulations

MF & CW: Part 2

New Initiative: Tech Support for newcomers

Killing QRM

Pictures & Video

Review: FlexRadio 6400

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Email us at info@vkradioamateurs.org

Cover picture credit: Paul VK3TGX

QTC from the Editorial Team

We've been overwhelmed with support for QTC – thanks to everyone who has sent us emails or simply asked to be added to our distribution list.

As we said in our first edition, QTC is a pilot. We will trial this free e-magazine before deciding how and where we take it in the longer term. So far, the feedback has been positive and encouraging. Hams from Australia are looking for something different, something truly digital and something that is targeted at our hobby in the 21st century.

In this edition we are pleased to bring you extracts from Ron Bertrand's extremely popular technical reference "***Radio Theory Handbook – Beginner to Advanced.***

It is the preferred reference book for most clubs and education providers, and Ron's team of facilitators at the ***Radio and Electronics School*** will help you prepare for the Australian exams to obtain your Australian Amateur Radio Certificate of Proficiency.

The most cost effective and practical path to obtaining your Australian amateur radio licence is to sit Australian examinations.

Ron has some firm views on exam question banks and rote learning. He discusses these with Glenn VK4DU.

In other news, we have a full house of information and updates from the ACMA.

You can read about changes to callsign regulations, the Syllabus Review Panel, 60m updates and the upcoming two by one (2*1) contest callsigns.

It is worth highlighting that 2 by 1 contest callsigns are a direct result of RASA's leadership and cross sector cooperative efforts over the last 18 months.

This month, RASA launches a new initiative targeted at supporting newcomers to the hobby. Please read this article, and if you can assist by writing Knowledge Base articles suitable for newcomers, send us an email.

On the topic of QRM, there is plenty of material to keep you busy; we have three articles from the field on RFI/QRM. Have a read of these; there might be something you could use to reduce or eliminate noise at your station.

There is a review of the latest in SDR technology and a video presentation on Pictures & Video by Chris VK3AML.

Ian VK3BUF has written an article on planning, deploying and protecting your antennas and feedlines. This is something we all need to read!

Welcome once again to QTC. We hope you enjoy this edition and we encourage you to send us your feedback, ideas, and questions.

73

QTC Editorial Team

editor@qtcmag.com

RASA Podcast

RASA now produces a fortnightly Podcast. This technology allows us to get regular messages to you at a time and place of your choosing.

You can download our Podcast by visiting this link – bookmark it!

Or search on vkamateurradionews on Apple iTunes.

Our email Bulletin has been re-named QTC-Lite and will include a transcript of the Podcast. It will be published every two weeks.

Should there ever be any urgent news, we will use QTC-Lite to alert our readers.

If you enjoy QTC please consider making a small donation.

Donate now

RASA Membership Renewal

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We believe we should be measured by our achievements. And we can only succeed with your support, so thanks to all our members and supporters for helping us make this happen.

And thanks to everyone who has sent us emails with feedback.

We listen to our members and respond to emails and questions about our initiatives, policies and priorities.

Please support us by joining or renewing your membership today. It's $8 and its easy – just follow this link.

Key Achievements in 2019-2020

- ✓ **Successful negotiation with ACMA for 2*1 Contest Callsigns**
- ✓ **Evidence based, professional proposals to ACMA – 60m and 1kW**
- ✓ **QRM Guru – reducing/eliminating QRM - on-the-ground help for amateurs**
- ✓ **Club visits – 15 clubs across five states**
- ✓ **Donations of ten QRM Club Kill Kits to clubs (value $1,600)**
- ✓ **Welcome to Amateur Radio Guidebook for newcomers**
- ✓ **QTC e-Magazine**
- ✓ **Donations and support for events: Antennapalooza, ILLW, OCDX Contest**
- ✓ **Membership up 49%**
- ✓ **Responsible financial management with a healthy surplus**

Detailed Achievements

Representation - Privileges

- **Lobbying and successful negotiation of 2*1 Contest Callsigns**
- Lead review of VK Band Plan updates with WIA to better accommodate digital modes
- Other key representation to ACMA:
    - Evidence based, professional proposal for 60m
    - Proposal for 1kW - addresses RFI and human health issues
    - Lobbying for Standard Licencees to have access to the full 50-54MHz band
    - Lobbying for Foundation Licencees to have access to Digital Modes
    - Lobbying for Foundation Licencees ability to construct equipment

Engagement with club & amateurs

- Visited 15 clubs across 5 states in 2019 (prior to Covid-19 lockdowns)
- Conducting Zoom meetings for clubs
- e-bulletin “QTC-Lite” sent to members and 125 clubs every fortnight

QRM Guru website

- Now an international resource – referenced internationally by clubs and societies
- Web site activity – 40,000 visitors, 130,000 unique page visits from over 80 countries
- 13 YouTube videos from the QRM Guru team
- 17 Case Studies from the field
- Online email support – over 30 individual amateurs supported
- QRM Kill kits – over 120 kits sold
- Informal support and endorsement from ACMA inspectors

RASA Website

- Approximately 150,000 visits over the last 12 months
- Informative articles on regulations, representation and current issues
- ACMA Lobbying information
- AR News and links
- Useful frequency lookup chart

Publications

- Welcome to AR Guidebook downloaded 1,400 times - free
- QTC-Lite e-bulletins – every 2 weeks to over 500 recipients and 120 clubs
- Podcast every 2 weeks
- QTC e-Magazine – 5,100 downloads – average of 2,600 per edition - free

On the Air

- Weekly nets during first Covid-19 lockdowns
- VI2020STAYHOME special event callsign
- WSPR Transmitter VK2RAS
- Reverse Beacon Node VK2RAS (in development, on air soon)

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- » Airport West: 5 Dromana Ave 03 9549 2121

New South Wales
- » Auburn: 15 Short St 02 8748 5388

Queensland
- » Virginia: 1870 Sandgate Rd 07 3441 2810

South Australia
- » Prospect: 316 Main Nth Rd 08 8164 3466

Products also available through our regional reseller network & Leading Edge electronics stores.

Regs & Representation

This regular column will focus on keeping you up-to-date with Regulations and how they impact our hobby.

The ACMA has been improving communication with amateurs recently with an email subscription service for information relevant to Amateur Radio.

We'll sift through the announcements as well as anything RASA is working on in this area and keep you updated. Of course, this means sometimes there may not be much to report…

Australian Communications and Media Authority

Callsigns & your personal information

As we have reported previously, you do not have to change your callsign if you move interstate. That's right. If you really like your callsign and want to take it with you when you move interstate you can do that now.

New callsign template

ACMA have implemented a new callsign template for Australian amateurs.

The template has been developed by ACMA and the AMC primarily to implement the changes to the LCD from 2019 – to provide 3 letter suffix callsigns for FL so they can fully utilise digital modes.

There are no changes to operating privileges (power, frequencies, etc).

Key points:

- no new VKnFxxx callsigns will be issued
- two-letter suffixes remain for Advanced licencees only
- new 2 x 1 contest callsigns for Advanced and club stations
- VKnRxx remain for repeaters and beacons; and
- **any three-letter suffix (apart from R) is available for any licence class.**

VK4ABC may be an FL, VK3ABC may be a Standard

A very useful and quick callsign lookup tool is available at: https://vklookup.info/

When applying for a callsign visit this page.

Frequently asked callsign questions

Q: I like my Fxxx callsign – do I have to change it?
A: No – change only applies to new callsigns

Q: I have upgraded to Standard from FL – can I continue to use my Fxxx callsign?
A: No – you must change to a new 3 letter callsign

Q: I have an old "standard" callsign (i.e. VK4NBC) – I would like to change it
A: You have to apply to AMC and pay the fees.

Q: Can I convert my Fxxx callsign by just removing the F?
A: No – you need to apply via AMC for a new callsign

If you are requesting a transfer of callsign (e.g. from a 4-letter to 3-letter call), tick the "Variation to an existing service" box on the ACMA form.

This will transfer your callsign allocation rather than create a new one as well as saving you some money.

2 x 1 contest callsigns

The other big news regarding callsigns is that ACMA have approved the issue of 2 x 1 contest callsigns with VJ, VK and VL prefixes, e.g. VJ1K, VK3R, VL5B, etc.

These callsigns are available for Advanced class amateurs and club stations, for contest operation only.

There is a limit of one callsign per licencee and one per club.

The 2 x 1 contest callsign structure was originally developed by a cross sector committee convened by RASA.

After a suggestion by AMC, ACMA has extended this structure to two new prefixes; VJ and VL. This allows 2 x 1 callsigns to be available to many more amateurs.

As we go to press (well, press the send button..) AMC were preparing their systems for the new 2 x 1 callsigns. They will advise when the callsigns are ready to be issued. Keep an eye on their web page.

State/Territory numeric vs QTH

When applying for a new callsign the state/territory numeric still applies – i.e. VK3 for Victoria, VK7 for Tasmania, etc.

However, there is no longer a requirement to obtain a new callsign when you move interstate.

E.g. Your callsign is VK1XX, and you move from ACT to QLD. You must notify ACMA of your new postal address but can retain VK1XX and do not need to sign /portable.

We conducted a survey on this issue a few months ago, and 71% of respondents were in favour of maintaining the connection between State/Territory and number.

We put this to ACMA, who advised that they would not change their decision.

If you feel strongly about this, we suggest you make your views known to ACMA by email to info@acma.gov.au .

Syllabus review panel

ACMA convened a syllabus review panel in November last year to modify the FL examination syllabus to include digital modes.

Unfortunately, after a face to face meeting in Melbourne and numerous email exchanges, the panel could not reach consensus on the syllabus changes.

The majority of the panel wished to include a simple explanation of transmitter duty cycle in the syllabus. Unfortunately, the WIA representatives did not support this.

ACMA will now revert to a public consultation process.

60m update

ACMA advise that submissions to their paper on 60m sharing between amateurs and commercial services are being analysed and will be considered by the ACMA board in the next couple of months.

ACMA 60m paper

You can read the ACMA Paper here.

And the RASA response here.

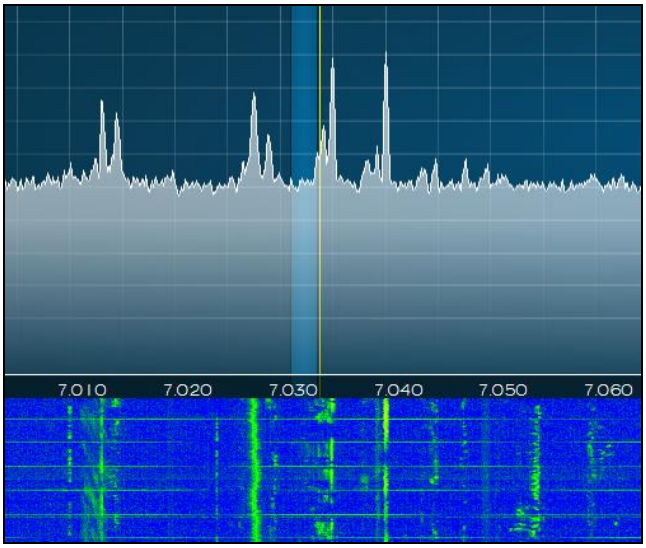
Broadcasters removed from 7100-7200 kHz

The ACMA have issued a public consultation on changes to the Australian Spectrum Plan as a result of decisions made at the last World Radio Conference.

The main change for amateurs is removal of broadcasting services from the 7100-7200 kHz segment of our 40-metre band. This allocation was suppressed internationally in 2009.

The ACMA consultation may be found here.

RASA writes to IARU again regarding 40 metre QRM



Many VK amateurs are only too aware of the QRM coming out of SE Asia most days and nights. We have received numerous reports of pirate transmissions that appear to be from Indonesia.

Two years ago, we wrote to the IARU seeking their assistance in resolving the matter. They advised that they had passed the issue to the Indonesian amateur radio society.

Unfortunately, the interference has actually become worse in the past two years; the very high popularity of digital modes around 7065-7075 kHz has pushed the pirates down below 7050 kHz.

As this is an issue that effects all of our region, we have written to IARU again, highlighting the problem, and asking what actions they are undertaking to resolve it.

For more information and to read our letters, click here.

Exams and Callsign Administration

Since early 2019, the Australian Maritime College has been providing exams and callsign administration services on behalf of the ACMA.

For more information, visit the AMC Website and following the links.

Training Courses

Looking to get your licence or upgrade?

If you are in Perth, contact Ham College for excellence in face-to-face training.

Preparing you for success with VK exams.

National Online and Remote Training from the Radio & Electronics School.

Amateur Radio Tech Support

The Radio Amateur Society of Australia is pleased to announce a new initiative to support newcomers to our hobby.

The ***Amateur Radio Tech Support Service*** (ARTS) is an online Knowledge Base with a ticketing support portal. It is aimed at newcomers and provides a selection of Knowledge Base articles which will be enhanced and expanded over time.

If a visitor wishes to ask a question or seek specific advice, the portal raises a ticket. Support agents, who are experienced hams, will review and respond to every ticket. This system provides the ability for the agent and the visitor to have an interactive email discussion until the question is answered, or the user can undertake further research themselves.

As a community we need to support newcomers and provide them with an environment and culture where they can ask questions, seek advice, and know that friendly reliable support is only an email away. The basic tenets of our hobby prevail: experimentation, learning and self-improvement.

The content of this resource is provided in good faith. The articles are targeted at newcomers to our hobby, or those who do not have a deep, long term exposure to the principles and practices associated with establishing and operating an amateur radio station. Sometimes, articles may gloss over technical detail for the purpose of brevity and practical application.

The scope of the pilot will be limited to entry level support for the following topics:

1. Basic Station set-up and housekeeping
2. Antennas – for at home and portable
3. Feedlines
4. QRM
5. On-air and DX operating practices
6. Regulations

Users must be willing to undertake further investigation and research and to determine or assess the suitability and applicability of the information provided.

Amateur Radio is a broad and varied hobby. We may not be able to answer every single question, but we'll do out best.

At this time, we cannot offer detailed support on computer configuration problems or digital modes.

Like QRM Guru, we'll progressively add to the content of ARTS. Common questions will result in a Knowledge Base article, and practical lessons will also be addressed with dedicated documents.

QRM Guru will also be linked to ARTS, allowing us to consolidate support, better manage follow up and collect statistics.

To visit ARTS just follow this link.

The ARTS home page is presented at the end of this article.

Please start by reading the "Getting Started" articles so that you understand how this resource works and what to expect.

How do I use the portal?

- review the Knowledge Base articles first;
- do your own research;
- conduct experiments;
- keep a log or journal of your experiments;

- ask questions via our portal or email address; and
- try to establish a network of fellow hams who can help you.

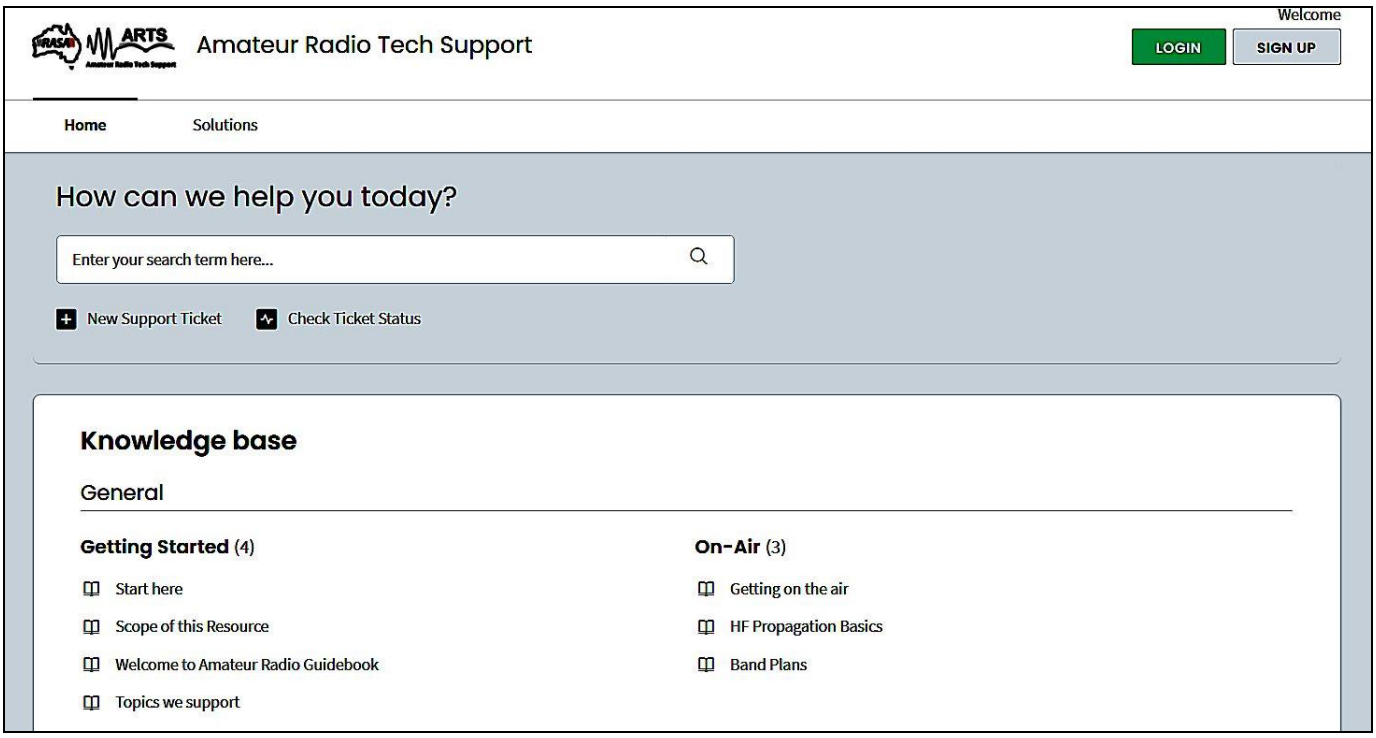
As with QRM Guru, you can type in your search phrase, or just a search word into the "How can we help you today" field and the Knowledge Base will present a list of documents that satisfy the search phrase.

If you can't find the answer you're looking for, open a ticket and send us your question. If you want to get an update on your ticket, simply click the "Check Ticket Status" button on the home screen. For this feature to work, you will need your email address to be validated – in most instances this occurs within 24 hours of you first opening a ticket. Just check you've received an email from us and clicked on the validation link.

Or you can send an email to support@amateurradiotechsupport.freshdesk.com

If you are an experienced ham and would like to contribute to this initiative, please send an email to this address. Like QRM Guru, this resource will only be successful if we all contribute to the Knowledge Base. We would welcome assistance in helping us write more Knowledge Base articles.

We look forward to helping newcomers and receiving your feedback.



Amateur Radio Tech Support: Landing page

Spectrum Plans & Band Plans

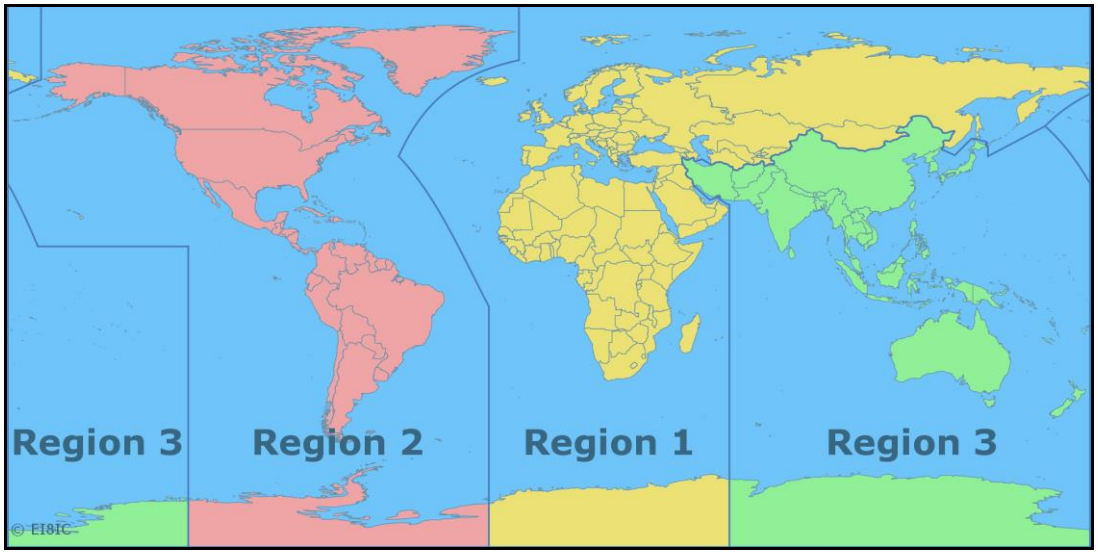
By Chris VK3QB

Amateur Radio Band Plans are complex beasts. It is too easy to think they are a "one size fits all" and consistent the world over. It might be attractive to think we can simply align ourselves with the IARU Band Plans.

However, nothing could be further from the truth.

Certainly, some of our long-standing amateur radio bands share a level of consistency across many regions, but the reality is that **there is no such thing as a global band plan**. Indeed, even within the three International Telecommunication Union (ITU) Regions there is limited consistency.

For ITU purposes, the world is divided into three regions. Region 1 is Europe, Africa and Russia; Region 2 is the Americas and Region 3 is Indo-Asia and Oceania.



ITU Regions - Credit: mapability.com

Why is this important and why should we care?

Management of the Radiofrequency spectrum is controlled by country administrations. This is as much a cultural and political situation as anything else, and is based on our geopolitical arrangements for national governance and sovereign control of resources. Country administrations work collaboratively through the ITU to achieve harmonisation as much as is practically possible.

Now, let us consider the Australian perspective.

First and foremost, the **Australian Radiofrequency Spectrum Plan (Spectrum Plan)**, set by the Australian Regulator, the ACMA, defines all Australian allocations. The **Spectrum Plan** divides the Australian radiofrequency spectrum into frequency bands. It is a legal instrument that specifies the general purpose and use for each band.

This **Spectrum Plan** defines the allocations granted to **Amateur Radio in Australia**. However, it only **specifies the frequency bands and their upper and lower limits**.

You can read more about the **Spectrum Plan** here.

The **Spectrum Plan** also specifies all frequency allocations and users across the entire RF spectrum. This includes everything from:

- Broadcast
- Defence
- Commercial
- Citizens Band
- Emergency
- Scientific
- Automation
- Satellite
- Mobile Phone
- Marine
- Medical
- Radio astronomy
- Navigation
- Aeronautical
- Land mobile

You can view the latest ACMA **Spectrum Plan (2017)** here.

So, here in Australia we have a well-defined **Spectrum Plan** and a mature political and legal system to manage compliance. We also have well developed Australian **Band Plans** which have been agreed by RASA and the WIA.

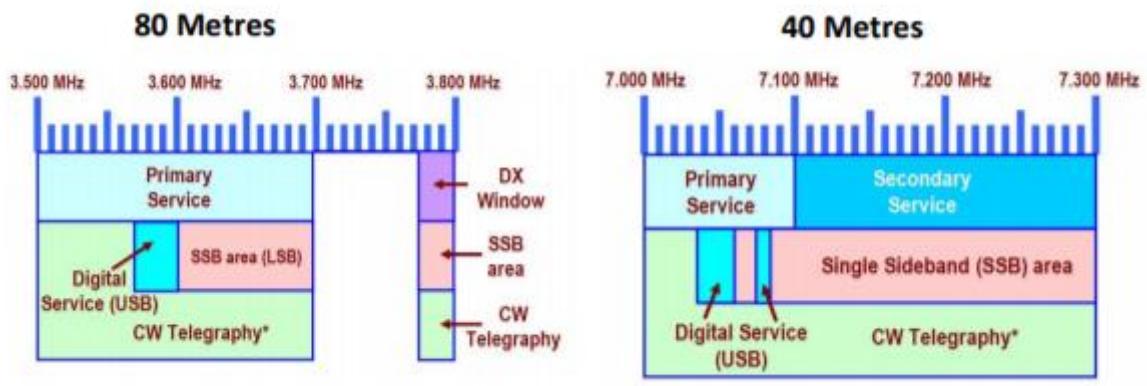
Now, what about these **Band Plans**?

Band Plans have developed over time within the international and domestic amateur radio communities. Band Plans have traditionally been referred to as "gentlemen's agreements" as they are not enshrined in law, and for us in Australia, are **not part of our licence conditions**.

Band Plans must, of course, be compliant with **Spectrum Plans**. There is no point having a **Band Plan** that conflicts with a **Spectrum Plan**.

Band Plans provide an agreed approach to share our allocated spectrum in an efficient and pragmatic manner. They enable us, as amateurs, to better use the spectrum, and recognise that certain modes and transmission types can be "lumped" into segments within our bands. This also allows for greater harmonisation and less conflict over how we share our bands.

Let us look at two popular bands and how the Band Plan has been defined.



VK Band Plan for 80 and 40 metres

For 80m, the **Spectrum Plan** defines 3.5-3.7 MHz (and then 3.776-3.8 MHz) and 40m 7.0-7.3 MHz.

The Australian **Band Plan** then divides these bands into segments based on emission (or mode). This promotes better use and sharing of our bands.

By keeping (for example) all digital modes within agreed boundaries, we permit many weak signal digital modes to operate without unnecessary interference from modes that require greater bandwidth and frequency agility; such as CW, AM and SSB.

However, all of this becomes problematic when we recognise that radio waves do not respect ITU Region boundaries or country borders.

And for this we are thankful. Achieving DXCC or chasing DX would be even more challenging if international law and policies were to govern how radio waves are propagated….

Problems arise when Spectrum allocations and Band Plans outside Australia do not align with our own definitions. Let us look at the IARU Region 3 Band Plan as an example.

Band	IARU Region 3	VK	Notes
160m	1.8-2.0	1.8-1.875	Following Region 3 would be **in breach** of the VK Spectrum Plan and our licence conditions
80m	3.5-3.9	3.5-3.7	Following Region 3 would be **in breach** of the VK Spectrum Plan and our licence conditions
75m		3.776-3.8	VK "DX Window"
60m	5.351-5.366	Nil (yet)	Secondary
40m	7.0-7.1	7.0-7.1	VK Primary
	7.1-7.2	7.1-7.2	VK Secondary, ITU Region 3 primary
	Nil	7.2-7.3	VK Secondary – ITU Region 3 does not recognise this VK allocation
30m	10.0-10.15	10.0-10.15	Secondary. ITU Region 3 does not recognise VK has SSB access to this band

Table 1: Comparison of IARU Region 3 to Australian Band Plans

Blindly subscribing to the IARU Region 3 Band Plan would create serious problems for us in Australia. Not only would we be in breach of the Australian Spectrum Plan, and thus our licence conditions, we would also forego some hard-won privileges; namely 7.2-7.3 MHz and SSB on 30m.

Why do countries have different Spectrum Plans?

There are numerous answers to this question.

- In some countries the military have a far greater influence over government policy
- local geography has determined different policies for access to certain bands based on need
- commercial and industrial needs
- economic development

- historical demand and government policy
- access to skills and technology
- population demand
- political will-power

These reasons are not entirely different to those applied to many other laws, standards and policies that vary from country to country.

All these geopolitical influences make regional and international band planning for Amateur Radio particularly challenging. So, the next time you're wondering why some amateurs in other countries have different allocations to us in VK, consider these issues.

Furthermore, we cannot simply demand access to new bands, or segments on the basis of "they have it, I want it too". Local **Spectrum Plans** here in Australia take precedence.

Band Planning for an international DX-pedition can be a complex activity. Agreeing on a single global frequency for FT8 or JS8 is also fraught. At least on some of the more common HF bands there is a greater chance of achieving international harmony.

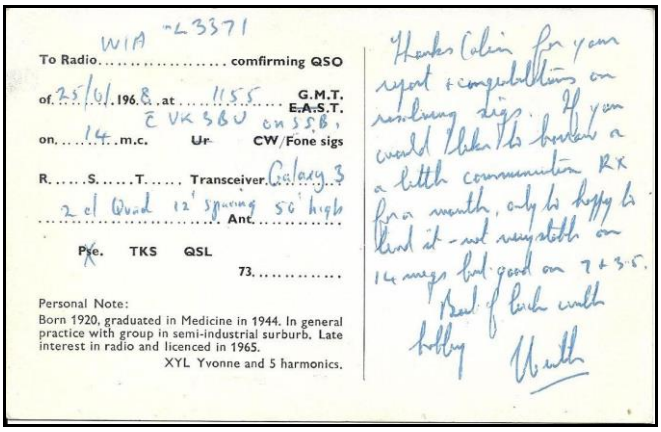
Locally, if you have not studied the VK Band Plan recently, please take a few moments. You can access a handy one-page chart here. And the WIA equivalent is here

Please be mindful of the digital segments on 80m: 3570-3600 kHz. We have plenty of spectrum above 3600 kHz for SSB nets and contacts. You may not even hear the weak digital signals between 3570-3599kHz.

We note that the VK2WI Sunday broadcast runs on 3595 kHz LSB - in breach of the Australian Band Plan. We have written to them requesting that they shift to a new frequency above 3603 kHz.

If you have any questions or comments, please, send us an email.

QSL Card Nostalgia


WIA L3371

To Radio..... comfirming QSO

of 25/01/1968 at 1155 G.M.T. E.A.S.T.

on 14 m.c. Ur CW/Fone sigs

R.....S.....T..... Transceiver Galaxy 3

2 el Quad 12' spacing 50' high

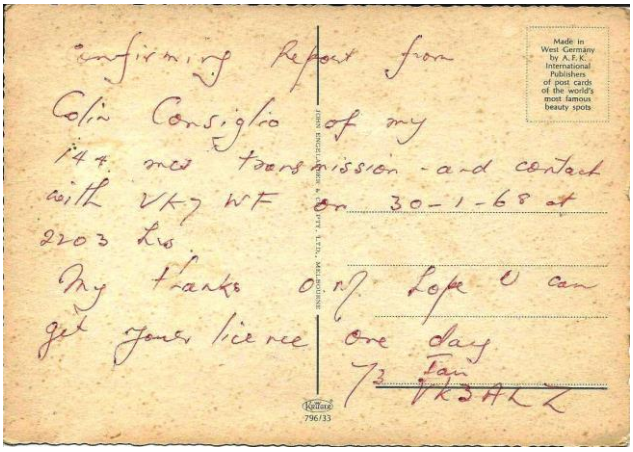
..... Ant.

Pse. TKS QSL

73.....

Personal Note:
Born 1920, graduated in Medicine in 1944. In general practice with group in semi-industrial surburb. Late interest in radio and licenced in 1965.
XYL Yvonne and 5 harmonics.

Thanks Colin for your report + congratulations on receiving sigs. If you would like to be back a little communication RX for a month, only too happy to lend it - not very stable on 14 mcs but good on 7 + 3.5.
Best of luck with hobby
Ulrich


confirming Report from
Colin Consiglio of my
14 mcs transmission - and contact
with VK7 WF on 30-1-68 at
2203 hrs
My thanks and hope U can
get your licence one day
73 Ian
VK3HLK

Made in West Germany by A.F.K. International Publishers of post cards of the world's most famous beauty spots

Courtesy of Colin VK3NCC

Trial examination question banks

By Glenn VK4DU and Ron VK2DQ

The WIA have recently taken it upon themselves to publish a trial FL examination question bank. We understand that this was done without any consultation with ACMA or the AMC (or RASA…but no surprise there…).

This is a major policy shift for examinations, with serious ramifications.

Ron Bertrand VK2DQ is one of Australia's foremost AR educators – his Radio and Electronics School has produced thousands of new amateurs over the last 22 years.

I discussed this issue with Ron, who has some strong, well-informed views. He is happy for those views to be put in the public domain. They follow below (in blue).

Ron says:

We have never had an open question bank in the history of amateur radio in Australia.

What the WIA board have done is enable a person to prepare for the Foundation licence by rote.

The Foundation is easy enough to study for properly and pass.

This is a shift essentially to a "published question bank".

I disagree with concept of a "published bank" as many learners will resort to the terrible exam preparation practice of memorising question and answer.

This will lead to very poor study practices and inevitably a lowering of standards of radio amateurs in this country.

This is what happens in the US. The banks are much larger and are changed every 12 months or so.

Very few radio amateurs in the US actually "study" for exams - they memorise by rote question and answer.

Go to Amazon and search for books to get a US amateur licence - you will find dozens and they are all simply question and answer guides.

If we are to go to public banks, the banks would have to be much larger - I prefer not to go to public banks at all.

The WIA board(s) of the past understood this.

I will be writing to the WIA board myself.

ACMA (of the past) never made the banks public because they understood that to do so would require larger banks that had to be constantly updated.

I am totally against public exam banks. They promote poor study practice and lead to a decline in standards.

There are two issues here intertwined - Making exam banks public and subverting the Australian exam system.

AR is a technical hobby. To be a successful practitioner requires a depth of understanding that cannot be obtained by rote learning.

Moreover, Ron and I firmly believe that anyone wishing to obtain an Australian amateur licence should use the legitimate Australian training and examination system.

Onwards & upwards: Medium Frequency & Wireless Telegraphy (CW) – Part 2

by 'Doc' Wescombe-Down VK5BUG & Chris Chapman VK3QB

Introduction

Low bands present a whole host of new (old) challenges for the radio amateur. Due to the long wavelengths at MF, more traditional and efficient antenna designs are simply impractical for most properties. Also, the design, engineering, mechanical and real estate requirements of full-size antennas are beyond the practical capacity of most hams.

Antenna efficiency is usually optimal when the antenna is resonant. Various resonant configurations may be achieved with MF antennas requiring size reduction or compaction due to prevailing real estate constraints. It is more important for a transmitting antenna to be resonant than one used solely for reception since radiation efficiency is usually significantly degraded by any mismatch in the entire station system.

Older hollow-state equipment with pi-tank outputs are much more tolerant of SWR aberrations than modern solid-state units. The latter usually include automatic protection circuitry to either reduce or shut down transmission power levels when SWR reaches 3:1 or higher. For this reason alone, hollow-state rigs hold their popularity with MF practitioners. Doc runs a Yaesu FT902D for 160-40m.

This month we'll introduce some of the practicalities of preparing to get on-air on MF. As already suggested, the higher frequencies don't present some of the same challenges as we find on MF.

Let us present a number of foundation principles to consider as you embark on your MF journey.

Starting out

If you're starting out and haven't investigated MF, then take some time to review the concepts and steps presented in this article. Start with a simple receiving antenna (e.g. AM Loop) or even your transmitting antenna and listen around the band. During daylight hours you'll hear local QSOs, out to maybe 300-500kms. This will depend on your signal to noise ratio and local conditions.

Be mindful that for most of us here in VK, working DX on MF is a huge achievement. Unlike fellow amateurs in NA and EU, most of us are thousands of kilometres away from the nearest DXCC entity. Start by working local VK and ZL stations as you improve your station.

If you can load up an existing antenna you could try for some local contacts. Your best options are:

- Tie the feeders together on an 80m dipole fed with open wire line as a top loaded vertical. Make sure you have a good counterpoise or radials.
- An inverted L, even if its sub-optimal. i.e. not very high and has bends on the horizonal leg
- A loaded vertical

As you spend some time becoming familiar with 160m, there are some key aspects you need to consider:

- The antenna and the Sandwich Model
- How much space do I need for an antenna?
- How big does a transmit antenna need to be?
- What about grounding?
- Do I need a separate receive antenna?
- Why does SNR matter?
- Will I have to change my operating habits?

We will talk about some important MF propagation considerations in the next edition of QTC.

The Antenna & the Sandwich Model

This model for antenna design and construction applies to all bands from 40m and down.

An antenna may be considered as a sandwich; two slices of bread, representing what goes "up in the air" and the other being what goes "in or on the ground". Your radio and its transmissions become the filling. The most important components in this system are the slices of bread. Without them, the "fillings" simply fall about randomly and you don't get a good result.

So it is with an antenna system.

If we omit, or only partially provide the top (antenna) and or the bottom (radials/ground mats) of the two slices of "RF conductor bread", it cannot, and will not perform as it was designed to do so. You can't mutilate physics without a negative outcome.

(MF Down Under. p83)

Remember: 40m and below – especially 160m

1. Install radials and counterpoises: as many as you can. Sixteen should be a minimum target. Thirty would be a practical optimum goal.
2. Use separate transmit and receive antennas to provide enhanced signal to noise option
3. Ensure short radial density close to the antenna feedpoint
4. Keep radials/earth mats as wet as possible
5. Ensure all radials, earthing and bonding to conductive materials has been completed. Make sure all joins are clean, mechanically and electrically sound and well-sealed.

Transmitting Antenna

W8JI asserted nearly all successful stations on 160m used a vertically polarised antenna of some sort for transmitting, and that was simply a fact. Briggs K1ZM (1997) noted:

"There are two very simple transmit antennas you can use to get started on Topband [and 630m] and both of these will generate a very effective transmit signal, even at exciter power levels . . . either will provide that all-important low-angle take off, so critical for working DX on the low bands. Remember, many antennas will work but the trick is to try to avoid the simple low dipole or low Inverted-V approach. Low horizontal antennas tend to shoot most of your radiated power straight up . . . Load your tower [and] the basic ¼-wave Inverted-L antenna"

(pp. 11-1 to 11-12)

A wide range of base, centre or top loaded verticals are used at MF, as are large vertical loops. Doc has created a generation of *'Big Bore Helical'* verticals using 75 to 150mm diameter PVC pipes as the winding formers, turns spacings of 10 to 30mm, and overall heights of 6 to 10m, thus being Council height compliant. They are 'quieter' in reception duty than plain verticals or Inverted-Ls, have operational 1.5:1 SWR bandwidths of around 25kHz and perform really well for local and DX action out to 10,000kms (embracing UA4 Russia & Ukraine, the sub-Continent, Asia and the Pacific regions).

Physical space will most likely be your key consideration. There is no exact answer, other than to state the somewhat obvious "the more the better". Having said that, if you live in a townhouse or unit, your endeavours on MF will be extremely limited and frustrating.

It would be more reasonable to expect a property of 600-800 square metres with adequate clearance to lay as many radials as possible or ground mats and bonding to any conductive materials.
Fewer, shorter radials will result in lower transmit efficiency.

Grounding
It is widely regarded as best practice to design and construct ground-dependent antennas "from the ground up". Anecdotal experience suggests that if we construct the radiating section first, we are likely to be tempted into getting on the air before the job is complete. Results will disappoint and we'll be discouraged.

Step 1: design the complete antenna system first. Take into consideration your block size, budget, restrictions such as building, garden beds etc.

Step 2: develop a radial plan and install them first. Start with the longest radials first, and at least four of them. Ensure all wires and connectors are cleaned first with emery paper, a pot scourer or Dremel grindstone. Refer notes on Radials below.

Step 3: Solder all joints that are connecting mechanically. Accept the expense and use stainless steel hardware; this will prove to be cheaper and more reliable in the long run. Apply conductive paste and seal every join.

Step 4: Install the feedline. Many practitioners prefer open-wire balanced feeders. However, for many, the convenience of coax is a preferred option. If you choose coax, to achieve maximum efficiency, you should ensure your antenna is resonant.

Step 5: Construct and install the radiating element. Start by cutting to formula plus 5%. It's easier to trim a little off the end if required.

Step 6: Assembly and testing of entire antenna system in a temporary fashion

Step 7: Make the entire system weatherproof, safe from the elements and ready to provide years of trouble-free service.

Receiving: Signal to Noise Ratio (SNR)

The ambient noise level is often quite excessive in urban locations these days. Theoretical antenna efficiency may be sacrificed with a negligible effect on received SNR. SNR is **the key factor** in Low Band ham radio operation, as promoted by the ARRL and others. This article by Hagan WA4GHK (1994) about reducing noise is worth reading.

http://www.lwca.org/library/articles/wa4ghk/gnd_isol.htm

Any research into Low band (40m and below) operation will soon reveal the desirability of having as many switchable antenna options as possible. At MF, instead of chasing forward gain any antenna may or may not have, we focus on front-to-side and front-to-back, with or without an RF pre-amplifier. Receiving antennas at MF usually have negative gain values, hence the importance of pursuing enhanced SNR.

Receiving:

On a suburban block, a separate MF receiving antenna may have its reception pattern distorted by interaction with an adjacent tower, transmitting antenna or some other conductive object/s. When pursuing remediation, do not be surprised if you try detuning from the operating position to minimise aerial switching and find it does not solve the antenna interaction issue. Always de-tune at the antenna base.

Much conversation may be had regarding Beverage arrays and their merits versus physical/space/engineering requirements. Let us first define what a Beverage is and turn to Briggs (1997) who wrote:

"This is probably the simplest and most effective 160-meter receiving you can use on Topband.

Named for its inventor, Harold Beverage, it is a very long wire, aimed in the direction from which you wish to hear DX signals. .
Up to about 2 wavelengths at its design frequency, the longer the Beverage, the better its performance. Lengths longer than 2[wavelengths] (about 1080 feet) become counterproductive."
(p.12-2)

Briggs advises optimal specifications for a 160m band Beverage begin with a minimum of 120 metres and range to either 163 or 327 metres, being mounted three to four metres high. Anything else is simply a random and low long wire.

Summarily, successful 630 and 160m receiving antennas need to capture and feed as much desired signal with as little noise, (man-made QRM and natural/atmospheric QRN) to the receiver as possible. Three types of discrimination are involved in that process:

1. Directional: attenuates noise and signals from directions other than any incoming from the wanted station.
2. Physical: achieved by erecting the aerial in the clear, away from house wiring, other buildings etc., when a feedline having no signal pick-up is used.
3. Frequency: a resonant aerial attenuates noise and signals on frequencies other than the resonant frequency.

An MF antenna needs all three if it is to deliver the optimum desired signal level and the minimum amount of noise at the receiver input.

Such an antenna, when connected to an average or mediocre receiver, will provide better results than the best receiver, connected to a mediocre antenna.

Knife Switch

Sharing a real-life scenario, Doc has opted for switchable monoband antennas which he feeds through a large ceramic knife switch (balanced loop with balanced coupler) and a 6-position coaxial switch (several monoband verticals).

One receiving loop is a horizontal 100 feet perimeter @ seven feet above ground, supported by long hardwood stakes strategically placed around the perimeter of a backyard 'orchard' and poultry area at tree-top height.

His second loop is a rotatable 10x10 feet 2-turn Frame Loop fed with balanced line about 11 feet above ground. Being bidirectional, only 90-degrees of rotation is required clockwise or anti-clockwise.

Loop Antenna

Please note, low doublet antennas fed with open wire line to a balanced link coupler are also very useful receiving antennas for Top Band. Doc's was 43ft 6ins per side and 20ft high, folded as a right angle in one backyard fence-line corner simply to fit it into the space available. It proved to be a great reception antenna for much of Europe during our equinoxes.

Extensive additional MF antenna information and step-by-step construction/tuning information may be found in Chapter 6 of *"Low Bands Ham Radio: 2020 Special international edition"* (2020), pp. 87-131 (available from the ARRL website).

We'll have more details on designing and constructing 160m antennas in the next edition of QTC.

Operating habits and achieving success on MF

With thanks to Doc VK5BUG, this list is reproduced in part from his publication "MF Down Under":

- Every day begins 30 minutes before sunrise;
- Sunset becomes much more than a romantic zone: it is part of Greyline;
- An urge to tune MF just prior to, during and following sunrise and sunset;
- Compulsion to be on-air between sunset and sunrise;
- Manipulating work and flexi-hours to facilitate the above;
- ***Always*** seeking to improve one's earthing systems;
- Avoiding family evening around the TV except to report new MF DXCC contacts or long-haul distance contacts;
- Persistence for years to work an elusive country or continent on MF;
- An irrational change in perspective where anything above 7MHz is regarded as VHF and gives you nose bleeds.

Whilst clearly tongue in cheek, this list should provide some insight into the mindset you will start to develop as the MF bug bites. These MF bands – starting with 160m – really do introduce a whole new challenge.

So, what is stopping you? If this series of articles has piqued your interest, start the process of designing your antenna system.

If you are able, start having a listen around 160m and maybe even try for a few local contacts.

In the next edition: More detail on antenna construction.

Killing that QRM

Welcome to our regular column of *Kill that QRM*. This column will be a little more conversational than many of the articles you'll find on QRM Guru.

QRM Guru is good place to start. So, get busy and send us your story of how you solved your QRM problems.

feedback@qrm.guru

And if you need some support, open a ticket by sending an email to

support@amateurradiotechsupport.freshdesk.com

This month we have a couple of stories from the field.

A remarkably interesting fault.

By Bob Tait VK3XP

Recently I decided to upgrade my UHF TV antenna. Whist connecting the coaxial F connector to the antenna I got a small tingle. I also noticed broadband 50Hz QRM on 40 and 80 metres.

Where was this coming from?

There were a number of possibilities. I recently had a new metal roof put on the house; could have one of the roofing screws pierced a lighting circuit?

I isolated the lighting circuits, but no change.

The roof was 108 volts RMS when referenced to ground, as was the TV mast and antenna.

What was the common denominator?

When I turned off the circuit breaker which supplied power to my TV and multi-media system the fault disappeared.

Next step… start from scratch and unplug everything: HDMI, power and antenna leads. I then reconnected the TV and the UHF antenna. All ok. As most of the equipment uses two wire power supply cables, I was measuring between reference ground and the chassis of each piece of equipment. I then connected the audio system. Again, all OK. Then the hard disc recorder and the HDMI link. Still OK.

Then I connected the Blu-ray Player power and measured between its chassis and ground and there it was. Suddenly I had 108 V RMS with reference to ground. The faulty unit was found.

What we had here was a daisy chain effect from the Blu-ray Player to the HDMI cable to the outer shield of the TX coax.

This fault was there even when the Blueray Player was turned off, so I concluded that it was a faulty common mode filter unit on the power side of the switch. That Bluray Player (Model BD-C6600) is now binned.

And my QRM on HF is gone.

Radial Free Verticals seen on eBay

By the QRM Guru team

From time-to-time we receive emails about QRM and TVI associated with these radial free verticals.

The symptoms will usually present as TVI, RF feedback and sometimes an inability to achieve a desirable SWR on the lower bands. We also hear of situations where the antennas appear deaf on receive.

Example of the radial free vertical

If you are considering buying one of these radial free verticals, we suggest you do some research first. Talk to others who have purchased such antennas and seek their feedback. Read some basic antenna theory handbooks.

You must:

- minimise unwanted currents in your shack;
- reduce unwanted interference;
- improve the efficiency and effectiveness of your antenna;
- reduce the likelihood of receiving RF shocks; and
- reduce unwanted interference to your radio, computer and electrical appliances.

Generally, radial-free verticals will perform poorly on both transmit and receive and you'll be disappointed with results.

The reality is that there is indeed no such thing as a free lunch.

These radial free verticals promise much and usually fail to deliver.

However, if you have invested your hard-earned and wish to find a compromise, we suggest the following as a series of guidelines.

You will need to do some investigation as you work through the issues.

1. With the advent of digital TV and streaming services, TVI is rare these days. Especially if you are operating a clean station with an effective RF earth, balanced antennas and your station and general housekeeping are in order. If you are suffering TVI, it is a clear indication of a serious problem.

2. Verticals, especially these 'radial free' designs are fraught. Whilst they appear convenient, they will nearly always result in unwanted stray RF, which may well be the source of the problem.

3. Bring the antenna to ground level and attach a good earth stake as close as possible to the base (an electrician's earth stake should be a good option). Also add as many radials as you are able. If you are living in a townhouse or unit and have limited real estate, this may be problematic.

4. Check the TV antenna and coax – it is all well maintained? Is the coax new or in good working order? Are all connectors in good order? Is there a mast head pre-amplifier in line? If so, is it required?

5. What transmitted signals (bands and modes) cause interference and how much power are you transmitting?

6. It is unlikely you would benefit, but Low Pass Filter (LPF) and High Pass Filter (HPF) may assist.

7. Is there a balun at the feed-point to the antenna? Again, there may be unwanted RF radiating from the feedline.

8. You could also consider trying ferrite rings to suppress unwanted RF.

There are a lot of unknowns with the scenarios presented with radial free verticals.

However, the first and easiest path to resolution is to introduce some earthing and radials.

Tracking down and resolving QRM and TVI is an iterative process. You should take notes as you work through the process and see what yields the best results.

Establishing an efficient and QRM free HF environment (especially on the lower bands) on a small block is a challenge.

Ultimately, a loop antenna may be a better option for your location.

QRM Kill Kits

Ferrite kits to suppress unwanted noise in your shack. Click the image to head to our online shop.

Build a simple DF Loop to help you localise and pinpoint the source of the noise. Click on the image to head to our online shop.

QRM.guru

Not much has changed in 70 years. We need acknowledge that the solution to our RFI/QRM problems is ours to solve; less talk, more action; visit QRM Guru for more information.

AMATEUR RADIO

Published by the Wireless Institute of Australia,
Law Court Chambers, 191 Queen Street,
Melbourne, C.1

EDITORIAL

"Will The Suppression of Radio Interference Ever Come To Pass?"

For years and years successive Governments have toyed with the problem of standardising the railway gauges throughout the Commonwealth with a view to firstly, the great economic value of such a scheme, and secondly—but of an infinitely greater importance—the immeasurable advantage to the defence requirements of our country. However, this vitally necessary change is still unaccomplished. Had it been carried out years ago the cost to the Commonwealth would have been vastly less than the astronomical figure envisaged today.

This may appear to bear little relationship to our interests, which are confined to the field of radio transmission and reception and electronics generally, until one recalls that we have a similar problem to face in the ever increasing "man-made radio interference."

Prior to World War II. the authorities were only interested in the problem insofar as it affected the broadcast listener and/or the commercial communications circuits. During the war the problem was brought to the front again with the great concern given to it by the Defence Services. But in spite of this, and in spite of the fact that great strides were made in the science of radio transmission and reception over these years, no major "attack" was made on the problem of interference of a man-made nature—and nothing has been done since!

With due respect, the Wireless Branch of the Postmaster-General's Department has rendered valuable service to the public and the Services in the elimination of interference problems insofar as the limitations of existing legislation will permit them, beyond which authority they cannot be expected to act.

Today the problem is becoming more and more urgent with the rapid expansion of the electronic art encompassing highly specialised and sensitive high frequency equipment used both commercially and militarily, more sensitive domestic receivers, and—of great importance within the next few years—television. With the advent of television, will come interference problems hitherto unknown in this country and the responsible authorities are going to eventually face an irate public if steps are not taken now to eradicate man-made electrical interference.

But of paramount importance is the need for the elimination of such interference as part of our defence preparation because in time of war sites for defence installations cannot be chosen with a view to freedom from interference, but must be where circumstances may demand. The elimination of man-made interference may well prove to be a vital factor in defence should there be another world war, bearing in mind the knowledge we have of the sometimes unsurmountable interference communications had to contend with during the last war.

We say without fear of contradiction that present legislation is inadequate to deal with the problem and that the case demands immediate and courageous action by the Government. The problem must be attacked on the highest political level and the fact that the taxpayer will be involved insofar as he will have to bear the cost of the complete overhaul of the existing electrical undertakings should not deter legislators from initiating an immediate programme of action.

The time has arrived when we feel that nothing further will be achieved by increasing the pile of correspondence already on Government files—only concerted action by those vitally concerned with the elimination of this problem can give impetus to the required legislation.

—FEDERAL EXECUTIVE.

Amateur Radio Magazine, July 1951

Noise Cancelling: a practical experience

By Phil Pavey VK3VB

Early March 2020 saw me working from home due to COVID-19. This led to re-establishment of the long-neglected shack, which was also the home-office. First, the digital modes were re-established with DSTAR, DMR and NXDN along with the standard 2m/70cm FM.

Over the past few years, my HF operation has been mobile or portable due to the extreme noise levels at home. I have been at this QTH for 20 years; over this time the noise levels have just continued to rise. I only have myself to blame for the largest issue. At a stage when I was not active on HF, we installed solar panels with micro inverters on each panel. The result when I tried HF again was full scale noise on all HF bands during daylight hours……

Initially, I decided that as I had to be at home I might as well be able to use HF at night, leading to the installation of a few wire antennas for HF. Naturally, I then decided to have a look during day light hours, but the result was as expected with no luck hearing through the noise. I could have CW contacts on 40m through the noise using the narrowest DSP BPF on the aging FT897D; more on that later. Running WSPR on various bands confirmed the antennas were radiating reasonably well.

When Victoria went into lockdown for the second time, I decided to try out a phase noise canceller and ordered an assembled kit from VK5TM.

https://www.vk5tm.com/homebrew/noisecancel/noisecancel.php.

An assembled kit without knobs or case delivered for $100 is exceptional value. I went the assembled route as I did not want to be scratching around for parts during lockdown.

Scouring the parts boxes, I was able to find a diecast box, and plugs sockets and switches required to complete the kit.

There is no VOX circuitry in the kit, so you are required to make connection from the TX ground on your HF set to ensure you don't feed RF where you shouldn't and damage the noise canceller.

To complete the kit, I had to supply a socket for the PTT sensing, install a transmit led and power led, a socket for the sense antenna, sockets for antenna in and transceiver, 12-volt socket and three knobs.

The VK5TM Noise Canceller

There are three controls – main antenna gain, phase 1 and phase 2. Tuning is a matter of placing all three at mid-point, then adjusting, starting with phase 2 to eliminate noise.

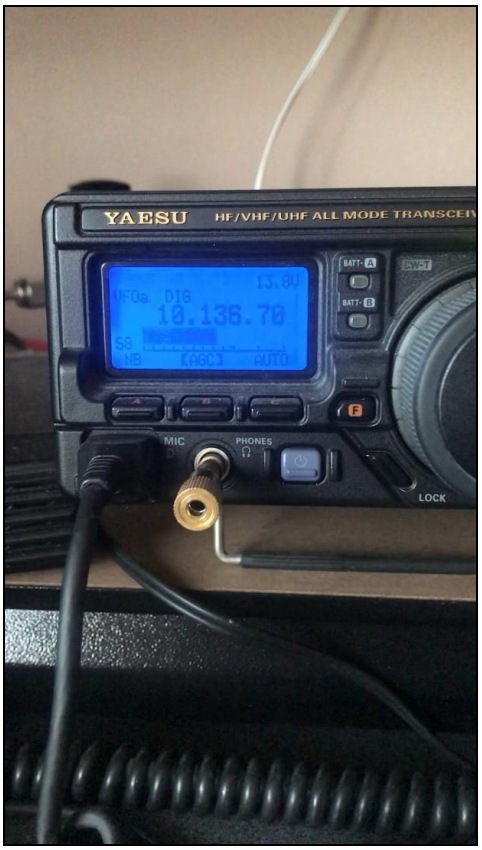
Keeping it really simple, the theory of these devices is that you supply noise from a noise sense antenna and match this at 180 degrees out of phase with the noise on the main antenna to cancel the desired noise source.

I'm going to say it – this thing just works!

Once I had the noise canceller connected to the transceiver, I initially connected a small telescopic antenna to the noise sense and had minimal results.

As I have two HF antennas, I connected the dipole as the main antenna and the sloper as the noise sense. I was able to null out noise and copy signals quite easily.

An added bonus to doing this is, provided both antennas can receive noise, you can reduce some band noise on 80m at night!



Noise on 30m - before

Noise on 30m - after

The pictures at left show the noise reduction I was able to achieve on 10MHz. These were taken in August at 4:30pm, so there would not have been full sun on the solar panels at this stage, but you can see that the noise has been reduced from S8 to S1.

There will also have been a reduction in the wanted signal – but if I can copy the station, that is a win to me! The noise antenna was a few meters of wire lying in the roof cavity directly under the solar panels.

As goal was to reduce the solar noise, I crawled up into the roof space and put an antenna right underneath the tiles where the solar panels are located.

I should highlight that on the manufacturers website he clearly states that the canceller circuit is not a cure for broadband, multiple noise sources.

If you are experiencing this sort of interference, you should probably be looking more towards wide-band DSP noise cancelling techniques. My noise definitely falls into this broad-band category and I purchased the canceller to see if would help. I was not expecting it to be the solution for every situation.

The canceller has three controls, gain for the transmit antenna and two-phase controls. As I write this, the noise on 20m is 30 over S9 without the canceller.

If I turn the canceller off, fully reduce the gain on transmit antenna the noise just from sense antenna is showing 10db over 9. (need to include here that probably too much from noise antenna and need to add gain control).

The canceller is “peaky” to adjust, but I can reduce the noise down to about S3. As I become more adept at this maybe I will be able to adjust it further. You will want to tune by ear, while also watching the S meter. This is because by the time the s meter drops you will find you have gone past the dip most of the time.

On 40m I can remove the noise down to the normal noise floor. Even when the noise seems relatively low, using the noise canceller was the difference when listening on WSPR between hearing 5 or 6 stations or hearing nothing.

My particular noise changes during the day. There is a pulsing noise as the inverters fire up at the start of the day, unrelenting noise during the day, and pulsing as the sun disappears.

What I now realise since using the canceller is the noise is actually varying during the day depending on cloud cover.

This means that I do have re-tune the noise canceller now and then as the noise changes. Even though to the ear the noise sounds the same every day, I have noticed that I can remove the noise very effectively on a cloudy day yet do not get as good a result on a sunny day.

On some days I change bands and either have to make no changes to the controls, or very minor ones. On other days a full retune is required.

While becoming familiar with the noise canceller I had the loan of a Kenwood TS590s.

What I noticed immediately was that the Kenwood was not nearly as impacted by the noise as the FT897D.

Noisy Yaesu

Quiet Kenwood…

Setting the two radios up as closely as possible to each other (so no DSP or noise blankers, pre-amp off on the TS590s and IPO (Intercept Point Optimisation) off on FT897) the noise was S6 on the FT897D and S3-4 on the Kenwood.

Those are the numbers. Reality was that 40m was useable on the Kenwood without the noise canceller.

One of the key lessons from this exercise has been to use all the tools you have available. I swap between the dipole and sloper to see which antenna has lowest noise and use that as the receive antenna.

If I can copy the station without the noise canceller I check and see which gives the most comfortable result. When the sun is coming up or going down the inverters tend to create a horrific pulsing noise.

The noise blanker on the Kenwood removes that almost totally, whereas the FT897 makes no change when you turn it on or off. When I have the noise canceller in line, I turn it on and off to see whether the noise has changed and receive quality is better with or without the canceller.

Another lesson learned is I do not worry so much about the strength of the signal or the noise but concentrate on the comfort and readability of the station.

As I write this, I am listening to the 160m morning net. Without the noise canceller in line I just have noise over S9. A quick adjustment of phase 1 and phase 2 and I am now enjoying listening to the net. The “antenna gain” is certainly not at maximum, but for me it is about the “readability five” and not the “strength nine”.

So, to summarise I can now listen to the 160m morning net, tune around 40m whenever I want and work strong stations on 20m.

I cannot remove the noise totally on 20m in the middle of the day, but when just plugging a short coax patch cable into the back of the rig gives at least an S6 noise, I would not expect to….

I think as I get more adept at adjusting the unit, I will get a better result.

I feel that at times there is too much noise being detected from the noise antenna, and at other times not enough.

I may have to install some more noise sense antennas, or investigate a gain control for adjusting the noise sense signal.

The combination of the noise canceller, using receive antennas and a more effective receiver has enabled me to get back on HF during the day.

Previously, I was convinced my only option was to have a solar installer put ferrites around the micro inverters. (and there are some great articles on www.qrm.guru on reducing noise on solar installations).

With a little research, perseverance, and investment of time (and a little money – about $200) I’ve been able to overcome my local QRM and get back on HF.

You can do it, too….

Pictures and video via Voice Bandwidth Radio.

By Chris Long VK3AML

At 56 minutes' running time, this is a long video presentation on systems that have already been demonstrated to work on HF and VHF.

If viewers have limited time, it may be better to view the video in three sections:

(1) From the start of the lecture to 25 mins 12 seconds is a discussion of narrow band (analogue moving image) television, with a historical coverage of the development of this mode, along with HF weather fax (WEFAX with FLdigi software) and the early days of Slow Scan TV. Webcam conversion software for transmitting a 1500 pixel image 6 times per second, devised by the Sydney experimenter Gary Millard, is demonstrated.

(2) From 25 mins 12 secs through to 32 mins 50 secs is a discussion of new and novel software-based "picturephone" modes devised by Con Wassilieff, ZL2AFP. He transmits pictures of 48 or 96 lines from his webcam conversion freeware over the standard 300Hz to 3kHz bandwidth of sideband and NBFM transceivers. The system can achieve between one picture per second and one picture every three seconds.

(3) From 32 mins 50 secs to the end of the presentation is a discussion of EASYPAL DIGITAL audio streaming of digital files - pictures, text files, .exe files or any other digital file. The EASYPAL freeware was devised by the late Erik Sundstrup VK4AES, and incorporates many refinements included over 15 years of development - return error correction, transmission via up to 57 interleaved audio subcarriers, DRM coding, Reed-Solomon error correction and matrix modulation.

Pictures and text can also be transmitted in this program via the audio analysis 'waterfall' display. In Melbourne, we have EASYPAL nets on the VK3RML 146.700 MHz repeater every Thursday night from 9pm to 11pm.

In the future, the usage of modems for picture transmission (fax) or heavily compressed video transmission, running at 9600 baud rate or higher, present a possibility for real video (heavily compressed moving image) transmission, but these have many problems in execution.

Such systems usually require handshake to a single target computer, with a full duplex reverse error correction system running. It might be done by crossbanding on HF with appropriately broadbanded software defined transceivers, but it would not be straightforward.

Selective fade, static crashes, poor signal to noise and multipath would all require software solutions in coding and error correction arrangements.

On behalf of the Melbourne EASYPAL group, we'd appreciate any feedback on this lecture video presentation."

Click this image to watch the YouTube video in full.

Note: you may need to drag the video back to the beginning after opening.

FlexRadio – a New Type of SDR Experience

By Chris Chapman VK3QB and Glenn Dunstan VK4DU

This review provides an overview of the FlexRadio 6400 and an insight into the experience using this state of art Software Designed Radio (SDR). It is not intended to investigate or rate technical performance specifications or validate technical performance results undertaken by others.

The review radio is the entry level model and requires an external computer to provide access to controls, view the panadaptor/ waterfall screen and access rig functions.

The FlexRadio 6400**M** has a more traditional radio look and feel (IC-7610 style), with integrated knobs and dials and an 8 inch touch screen.

FlexRadio 6400 – black box! No knobs, dials or screens

FlexRadio 6400M – Same radio! But with knobs, dials and screen

SDRs have been around for about 20 years. FlexRadio introduced its first SDR (SDR-1000) in 2003 and the technology has undergone considerable development since. Most other mainstream amateur radio manufacturers offer SDR technology (Yaesu, Icom, Elecraft, Apache Labs).

Basic overview – what is the FlexRadio SDR

SDRs are made up of two key components; the hardware and the software. SDR have implemented much of the RF processing into software. This is a quantum leap from traditional transceiver design and provides an entirely new way of thinking about how we use our radios.

FlexRadio calls their software SmartSDR, and it runs on several platforms: Windows, MacOS and iOS (iPad & iPhone). We'll come back to this later.

The FlexRadio receiver (the hardware) consumes the entire MF, HF and 6m spectrum and converts it from analogue to digital data; this is a key difference to the traditional Superhetrodyne receiver which is limited to receiving only one signal at a time.

An internal central processing unit (CPU) in the FlexRadio, called the Spectral Capture Unit (SCU) handles the huge amount of data generated by this process. The SCU is an order of magnitude more powerful than an Intel i7 processor and this removes a lot of the processing from the computer, whose main job is now concerned with rig control and video functions.

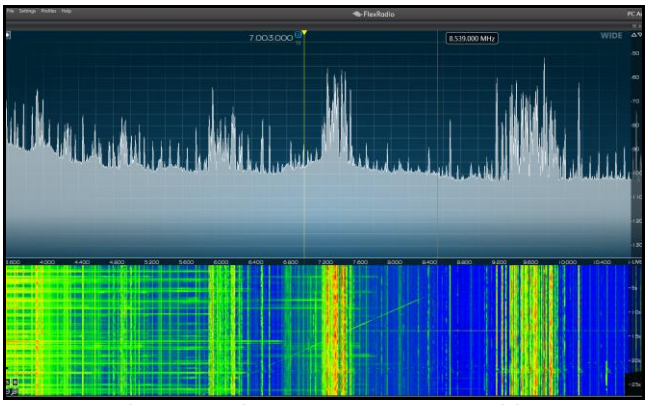
Working with digital data means the radio (software) can select the exact signal (i.e. the data bits) the operator chooses, and any surrounding signals or interference are simply discarded. This makes for outstanding selectivity and suppression of nearby interference from strong stations.

This theory plays out in day-to-day use of the radio.

The other key benefit is that the radio behaves more like a spectrum analyser; you select the band width you're interested in (up to 7MHz in width, anywhere in the MF, HF and 6m spectrum).

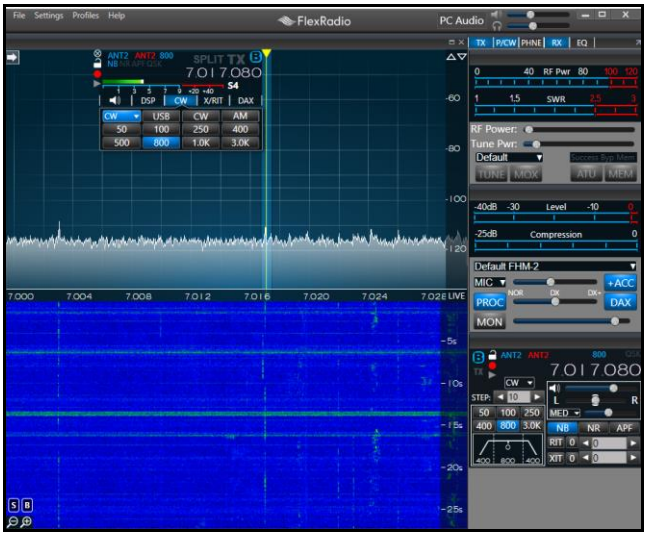
The SCU collects all the data and the SDR software (SmartSDR) presents all signals in that range on the panadaptor screen. The panadaptor is a visual representation of the frequency range the operator selects; a subset of the entire HF spectrum.

This screen image covers from 3.6MHz to 10.4 MHz



Flex Panadaptor – up to 7MHz wide

In and of itself, this feature is very powerful and interesting. With a single glance the operator can inspect a swathe of spectrum and drill down to areas of interest.



Panadaptor, Waterfall & Receiver slice

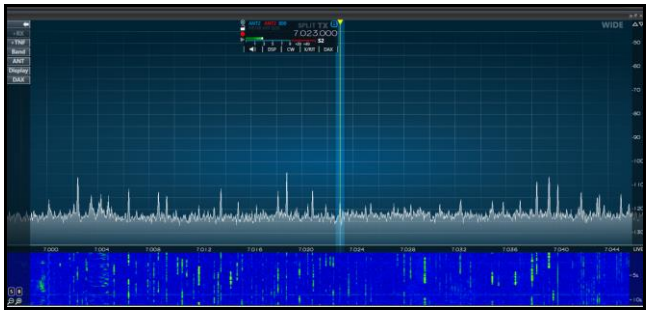
What we use to "listen" to a signal is referred to as a receiver "slice" in FlexRadio parlance.

The top half of the screen is the panadaptor and provides a visual of 7.000-7.028MHz (the X axis). This is displayed in real time and the Y axis shows the signal strength. The window in the top centre controls the receiver "slice", on 7017.080. This window can be closed, and the "slice" can be controlled from the Radio Panel on the right-hand side of the screen.

The waterfall display occupies the bottom section of the screen. This displays signals (and noise) over time. The heavier and brighter the signal marker, the stronger the signal (or noise). In this case, the waterfall displays the last 25 seconds of activity as signals scroll from the top of the waterfall display (real time) to the bottom (25 seconds of history).

The receiver "slice" can then be tuned in much the same way as a traditional radio. Mode filters, noise, DSP, equalisers and other filters can be applied. The FlexRadio 6400 has one SCU and can run two independent receiver slices i.e. you can listen to two separate signals completely independent of one-another, anywhere in the MF, HF and six metre spectrum.

The two bigger brothers of the 6400 – the 6600 and 6700 – offer 4 and 8 slice receivers, respectively.

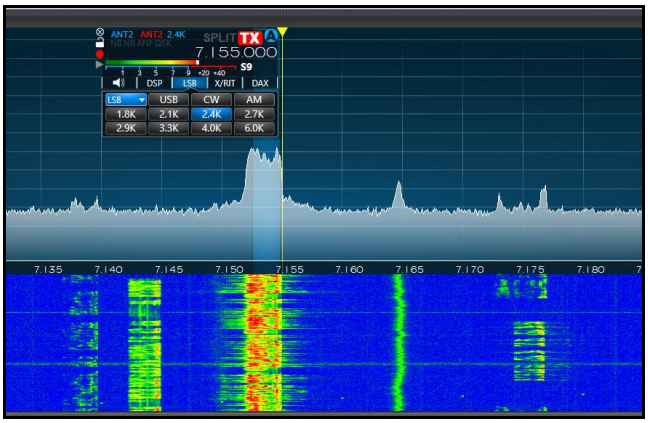


Panadaptor and waterfall display on 40m CW

The image above was taken at about 0200 hours in VK3 and illustrates the activity on 40m during a European CW contest.

With the visual insight into the band, you'll never "see" radio the same way again.

Indeed, the authors would find it near impossible to revert to a traditional radio lacking a panadaptor and waterfall display.



Panadaptor and waterfall – on 40m SSB

The example above illustrates the SSB segment of 40m. Another benefit of the panadaptor and waterfall is being able to see the bandspread of signals.

The signal in the receiver "slice" on 7.155 MHz has voice compression switched in, is probably set too aggressively and is "bleeding" over, creating a wider signal than intended and some splatter.

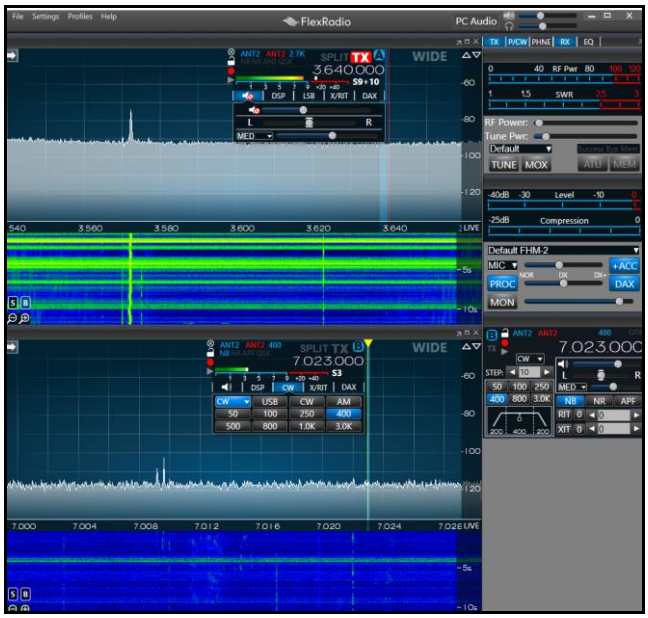
Operating the FlexRadio

The radio can be operated entirely with a mouse and a keyboard, although FlexRadio offer a VFO knob for the die-hard traditionalists. The VFO knob provides a good halfway house between a traditional box with knobs and a PC screen/mouse.

Indeed, the authors are both keen digital and CW operators and the FlexControl VFO Knob makes operating more tactile and enjoyable.

The 6400 has 2 independent receivers – you can set it up with two complete waterfalls/panadapters and frequency readouts. Either receiver may be tuned to any MF, HF band or 6m – you could have one receiver monitoring the SSB section of 40m, and another listening to a CW QSO on the same band, or one receiver on 20 and the other on 6m, for example.

Equally, you could be working FT8 on 30m and monitoring the CW segment of 40m at the same time.



Two panadaptor and waterfalls on 40m CW & 80 SSB

SDR, and the FlexRadio in particular, really shine when it comes to filtering. As mentioned earlier, the FlexRadio samples the entire spectrum and then discards the signals you aren't interested in.

The signal/s that are left are processed in the receiver "slice" and you have the full gamut of software processing to eliminate noise, narrow the filters, equalize audio profiles and maximise your chances of copying that station.

One powerful feature is the Tracking Notch Filter. These filters are dynamic and can be varied easily to notch out unwanted interference. You can have as many of these notch filters as you want; perfect for eliminating QRM. As the name suggests, these filters track the interference as you move around the band.

The FlexRadio allows you to switch between two tx/rx antennas and/or a dedicated rx antenna like a loop.

Any of the antennas can be configured for either of the two tx/rx and/or configured for particular bands.

You can easily switch between two antennas (point and click with the mouse) to compare reception; for example, switching between a vertical and a dipole.

The 6600 and 6700 models are configured for diversity reception using two different antennas.

Remote operation

The FlexRadio may be remote controlled over your local shack/house LAN – you can operate it from a PC, a tablet or the dedicated "Maestro" remote controller anywhere in the house.

You can wander around the house with your iPad monitoring your favourite HF band or sit by the pool with a refreshing beer and work the DX….

FlexRadio Maestro stand-alone control unit

The Maestro is a stand-alone control unit for the FlexRadio, providing a more traditional radio look and feel. All you need is an internet connection and you're good to go; in your house, at work or on holiday.

Of course, the remote-control possibilities of the FlexRadio are only limited by your imagination and the internet infrastructure available. The FlexRadio may be remote controlled over IP from a remote site – this could be the hill up the road or a friend's shack on the other side of the world.
The remote control is fully seamless – the only thing you can't do (yet) is use a paddle for the in-built electronic keyer.

Integration with other software

The FlexRadio offers cableless integration to popular logging and digital modes software. Also, callsign spots from DX-clusters can be displayed on the panadaptor, right alongside the actual signal…

For digital operators, integration of WSJT-X (FT8) and related software is seamless. No cables, no special drivers and no frustrations.

A collateral benefit with fewer leads and cables is less opportunity for common mode radio frequency interference (RFI/QRM).

Platforms

The FlexRadio software SmartSDR works with Windows, MacOSx and iPad/iPhone platforms…yes, you can use your HF radio from your mobile phone… Again, this is a whole new paradigm for amateur radio. Contesters, DXers and rag-chewers can operate whilst on holiday or working away from home.

Support

FlexRadio customer support is excellent. You're not just buying a radio. You're buying into a whole community of support, education, information sharing and upgrades. The local dealer here in Australia, Steve Kennedy VK6SJ of Future Systems is helpful and responsive to enquiries.

Local support is, of course, important. But FlexRadio really shines with its online support and user-engagement model. This is a support arrangement we've not seen in the amateur radio market, and it makes for a refreshing experience.

The support is delivered via multi-channel online platforms using various social media and tailored support resources.

The offerings are:

Support Centre

The Support Centre is accessed from the FlexRadio web site. Documentation including: 21 "how to" guides, 15 "getting started" guides, data sheets and related information. There are also videos covering FT8, the Maestro and SmartSDR.

Helpdesk

FlexRadio provide an online Helpdesk and online ticketing system for reporting problems to the developers – the service is easy to use and anyone who has used an online ticketing/problem reporting system will be familiar with its operation.

One of the authors raised a ticket shortly after receiving the radio. The response from FlexRadio was quick (i.e. less than 4 hours) and the technician was helpful and friendly. Observations from the broader community on Facebook suggest that most users are very satisfied with FlexRadio's tech support.

FlexRadio Community

For asking questions, raising a discussion topic or raising a new idea in a moderated environment – The FlexRadio Community is a forum where members can interact with one another and directly with company employees to enhance the operating experience with products and services. It's another great resource for learning about and researching FlexRadio products.

Facebook page – FlexRadio Enthusiasts

As the name suggests, this group is dedicated to FlexRadio enthusiasts. It has almost 3,500 members and is very active. The moderators maintain a tight ship and all interactions are respectful and helpful.
FlexRadio have made a clever decision and have an employee embedded in the group. Michael Walker VA3MW is a keen amateur and (naturally enough) a FlexRadio user.

He is also a moderator of the group and plays a key role in maintaining a collegiate environment, as well, of course, as providing a channel to/from the company.

YouTube Channel

Over 70 instructional videos – these cover everything from general overviews through to using specific functions, matching amplifiers and configuring digital modes like FT8.

This level of customer support and direct engagement is unheard of in the Amateur Radio world. FlexRadio are to be congratulated for providing this service rich, friendly and engaging level of support. It really adds to the overall user experience of learning to get the best out of the radio and share ideas and experiences with fellow FlexRadio users.

Software Defined Radios bring a whole new experience to Amateur Radio. The advantages and new features of this technology really do open a whole new paradigm of amateur radio. If a new radio is in your sights and you haven't considered an SDR, take the time to read reviews, watch YouTube videos and talk to users.

Being able to see the spectrum and a wide range of signals really changes the way you'll think about "listening". Most people we've spoken to who have made the transition to SDR technology are extremely happy and rave about the features and usability.

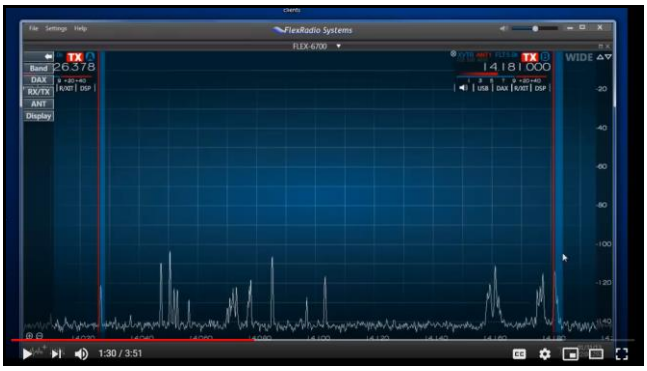
Like any radio, there will be nuances and features that don't meet the expectations of every operator, and the Flex is no different in this regard. However, the FlexRadio offerings are certainly at the top of the line and you'd be doing yourself a favour to consider this range of radios.
The entry level FlexRadio 6400 sells for AU$3,550.

For more information visit the FlexRadio website.

And the local VK dealer, Future Systems.

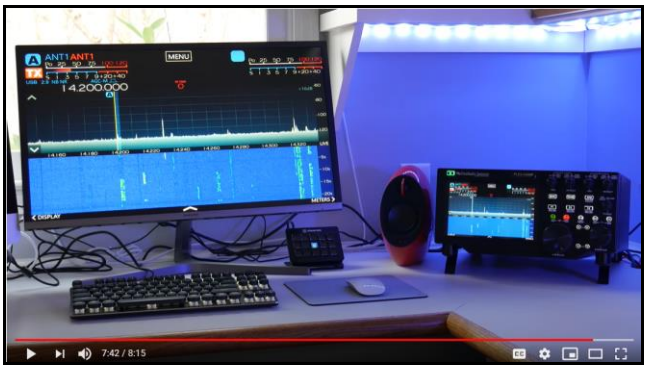
We have included a couple of videos from the FlexRadio YouTube channel to illustrate the power of this technology.

SmartSDR Multiple Slice – Multiple Panadaptors



Flex 6400M Quick Look

This video illustrates the use of the Flex 6400 with the Maestro, remote operation with a Microsoft Surface and the FlexControl VFO knob, iPad, iPhone, Apple Mac and PC.



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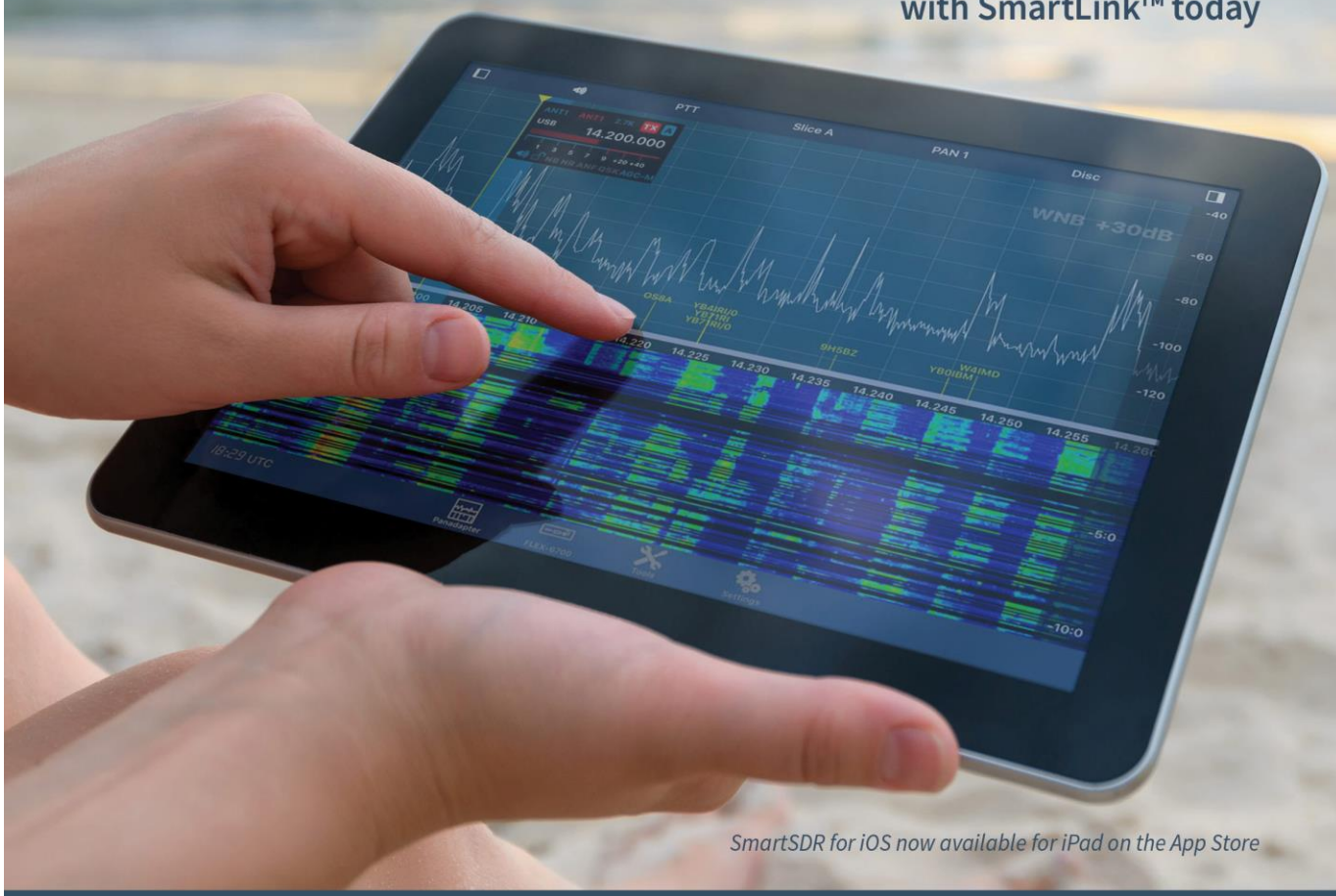


SmartSDR for iOS now available for iPad on the App Store

futuresystems.com.au | sales@futuresystems.com.au | 08 6336 9610

Prices as of July 2020, prices are subject to change without notice

Covid-19 and Amateur Radio

Covid-19 has both positive and negative impact on Amateur Radio

The pandemic presently sweeping the globe continues to have an unprecedented impact on our lives. Some places like Greater Melbourne remain under intrusive but necessary restrictions, while other regions are more relaxed. Large gatherings remain limited.

This is having a significant impact on some Amateur Radio clubs, many of which have long established customs of getting together every month or so.

However, we know from retailers and training organisations that overall activity is up. More people have time at home, and this has translated to more of us tuning around the bands or trying out new modes. There is also a resurgence of lapsed operators returning to the hobby.

With Clubs it is harder, as the regular personal contact has been disrupted. Many clubs have reverted to meetings via Zoom and/or on their local repeater.

These are excellent initiatives and represent what our hobby is all about; using technology to communicate.

There is a lot we can do as individuals and as members of clubs to hold the club activity together until normal life has resumed.

Activities for Prospective radio amateurs

Those not yet licensed can use this time to prepare for Amateur exams. If your local club is not running courses, consider online and remote options from the Radio and Electronics School. Ron VK2DQ and his national team of facilitators provide an excellent service to prepare you for *Australian* exams.

Another good starting point is to download the RASA guidebook, Welcome to Amateur Radio.

Exams, including Remote Assessments, can still be conducted by authorised assessors from the Australian Maritime College (AMC).

An opportunity to upgrade

Amateurs who already hold a Foundation or Standard license can use this time to study and upgrade their licence. Try to link up (electronically) with others also wishing to upgrade. Shared ambitions can break through isolation and build routine and commitment into the study regime. Again, contact RES if you need help.

Clubs can consider alternative activities

The cessation of Hamfests, field days and general meetings have put a halt to many common club activities. Consider what your club can do to move traditional activities to the online world; send a link to an interesting video and then have a Zoom meeting to discuss the video… or a Q&A session with an expert in the field. Some clubs have already picked up on these ideas with great success.

Maybe members can provide a virtual tour of their radio shacks and antenna farms? This could lead to interesting discussion, Q&A and sharing of ideas… leading to further exchanges of information by email and on-air.

Survey your members; they might want to meet online more regularly.

Some clubs now run weekly Zoom meetings. What's important is to maintain momentum and interest. Keep the members together, so when restrictions ease, the transition back to traditional club meetings will be natural.

Most clubs put together a regular newsletter or magazine. This is a task that is even more important in these times of isolation. Seeking interesting content from members (and other sources) is also important. Maybe you can share articles with other clubs?

Seek out that elusive interference source (QRM)

The quiet time at home can also be an opportunity to attack that annoying RFI/QRM. Take note of the noise levels on each band, then go on a witch hunt.

Assemble a DF loop, turn your appliances on one at a time to see if they are contributing to the noise. Buy some ferrites and put them to work.

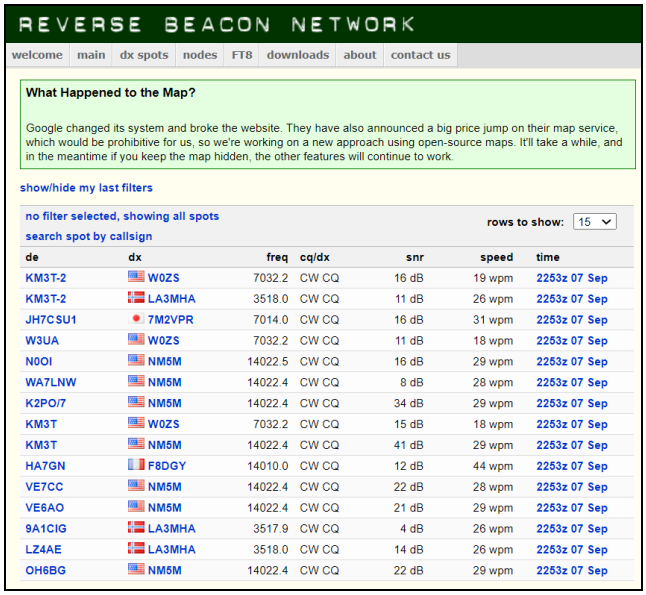
Your efforts can also be a topic of a club meeting on Zoom.

If you can drop the noise level in the shack by a few S points, perhaps you will also improve AM/FM broadcast reception and Wifi performance as well.

Visit www.qrm.guru for tools, techniques and case studies to assist you in your efforts to eliminate RFI/QRM at home.

The hobby of Amateur Radio itself is the biggest activity of all. Whether it is construction projects, DX or contest activity, there are plenty of aspects to keep every amateur busy in this very unusual year of 2020.

FISTS Grant for Reverse Beacon Network



RASA reminds clubs that the CW Preservation Society, FISTS Down Under, still have financial grants of up to $500 available to assist in expanding the Reverse Beacon Network here in Australia.

Read more at their website fdu.org.au. or send them an email.

To learn more about the Reverse Beacon network, visit reversebeacon.net.

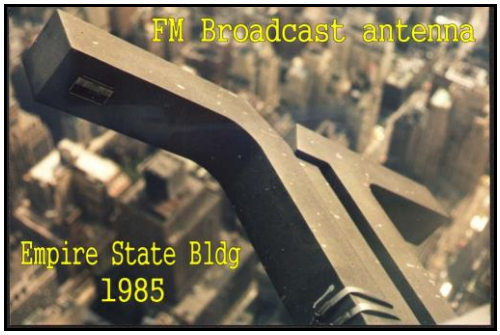
Protecting your Antenna from the Elements

By Ian Jackson VK3BUF

K*eep your powder dry* is an old maxim that serves to remind us of the importance of preparedness. This is a compelling approach for anyone tasked with erecting a new antenna for the home station. It matters little how fancy your radio is in the shack, if the connections to your antenna are wet and degraded. Inefficient or damaged feedlines can render your station inoperative.

In the commercial world, antenna systems are built to exacting standards and no expense is spared for fittings, as this is a small cost relative to that of getting a professional rigger on-site for remedial work.

For example, this antenna is part of an FM broadcast array installed on the top of the Empire State Building in 1965. I photographed this image in 1985. Thirty years later another visiting VK amateur took a picture of the same antenna. When we compared images, the antenna was still in perfect condition.



Some amateur antenna installations tend to be fleeting. Perhaps it only requires a few bits of tape and some ties to be good for a weekend or two. This is fine for experimental work, but if an installation is destined to last much longer, more effort is needed.

This article presents a range of strategies that will preserve your antenna systems from the ravages of time and the elements.

Using the right products and thinking ahead can make a real difference to the reliability of your station and ultimately, your enjoyment of the hobby.

Leaving the house

When planning the path antenna feedlines will take from the shack to the antenna, consider how the feedlines will enter your home. This may involve a bundle of several cables of differing sizes. Perhaps it will include one or more runs of the heavy RG213 coax, or some of the thinner and more flexible RG58 feedline. Additionally, the run may include cables for an antenna rotator, coax relay, or control wires for a mast-mounted antenna tuner.

Where homes have timber floors, it may be expedient to use the floor cavity. This could be via a hole drilled in a corner, perhaps under a lifted triangle pf carpet, or through a plastic flush plate on a wall.

MFJ make a series of stainless-steel wall plates for this purpose, which makes a neat and serviceable cable exit point.

MJF Wall Panels

Once under the floor, the cable should take the shortest path possible to minimise losses. A good outlet is a sub-floor air vent closest to the antenna site.

From there, make a direct path to the mast or tower, taking care not to create a tripping hazard, or allowing the cables to become vulnerable to lawn mowers.

Sometimes that path isn't viable. Perhaps the floor is solid concrete, or the landlord prohibits such installations.

An alternative is to fabricate a narrow panel, perhaps 100mm wide that can fill a space in a partially opened window. When fitted correctly, window panels can remain secure and watertight.

Whenever cables do exit the side of a house, ensure that they first loop lower than the entry point. This is essential to allow rainwater to drip from the lowest point of the cable, rather than providing a path for water to flow into the building.

If you have the luxury of running conduit to the base of the mast or tower, ensure the open end includes an inverted-U to stop water filling your conduit. Using three or four 45º elbows is better than working with two 90º elbows. The smaller bends are far easier to work with when it is time to haul fresh cables through these sections.

45º elbows for weather protection

When choosing conduit size, consider the total diameter of the cable bundle, then roughly double it. While a tighter fit may appear neat at the outset, it is better to allow for additional cable runs if required.

Remember to leave a strong draw-string in the conduit, as at some point it may be necessary to pull through an extra cable.

When that time comes, a good draw-string makes the difference between a simple job and a very difficult one. A synthetic clothes-line cord is excellent for this purpose. As this cord has a high UV stability, it is excellent for hoisting wire antennas up a tower or tree.

Going through the roof

Some antenna installations attach to the roof of the house. Perhaps a section of pipe will enter through a roof tile, supported by additional timbers bolted to the trusses.

Avoid nailing directly to trusses, as over time, nails will to work loose. Coarse threaded wood screws, tech screws or bolts are a better choice.

There are some excellent flashing products called 'DekTite' designed to waterproof protrusions from concrete tiles and corrugated metal roofs. These follow the contours of a roof and may be seated with a few well-placed dollops of silicone. Most roof flashing products are available from plumbing suppliers and larger hardware stores.

Dekite waterproofing

Coax cables can pass through partially lifted roof tiles but take care that the cable does not get crushed in the process.

Attach a small section of thin conduit or dowel to the coax as it passes through a tile gap to take the pressure from what could be a cable crush-point.

Sealed enclosures

Sometimes weatherproof boxes are attached to a mast to protect critical components such as baluns and terminal strips. It is important that these enclosures are water-tight to prevent water ingress and the resulting damage. Typically, outdoor enclosures will have weatherproof, gasketed lids. Ideally cables will enter the enclosure from the base, (not the side or top) via an appropriate cable gland.

There are two trains of thought here. We want to keep rain and bugs out, so a common strategy is to simply seal the enclosure securely. Unfortunately, sealed enclosures also hold water extremely well. If water *does* get in, or condensation builds up over timea lot of expensive equipment may be ruined by water damage.

In most outdoor situations it is safer to drill a 3mm drip hole in the base of any enclosure to allow water or condensation to drain. This is preferable to having a 'sealed' enclosure slowly fill up.

A small stub of woven cord can be knotted and dangled through the drain hole to prevent insects from gaining access. Water will leech through the cord via capillary action.

When any outdoor enclosure is open, a short preventative burst of bug surface spray can dissuade insect invasions for some years.

Metal corrosion

Antenna installations inevitably involve sections of galvanised and aluminium pipe, U-bolts, hose clamps, bolts, washers and nuts. Usually there are several types of metal involved.

In these situations, there is a real risk that dissimilar metals, with the presence of water acting as an electrolyte, will result in rapid corrosion. When exposed to extended periods of rainwater (or worse still, salt-water spray) aluminium and zinc will corrode quickly.

The rusting zinc plated bolts shown here were located 30 metres above the ground. They held the aluminium plates of a 6M repeater J-pole antenna. On windy days, they introduced constant noise into repeated transmissions.

Rusty hardware fittings – not good

Even though an assembly may be structurally sound, corroded junctions can behave in strange ways around RF fields. Poor earthing through rusting brackets can generate lots of crackles on signals well into UHF.

Oxidised brackets can also exhibit similar characteristics to that of a crude semiconductor junction. In the presence of strong RF fields, mixing and re-radiation can occur up and down the radio spectrum.

Rapid corrosion also takes place on cadmium plated bolts and fittings. These are easily identified by their dull-gold colour.

The following image illustrates the progress of corrosion on a U-bolt clamp attached to an aluminium tube.

These three images (next page) show its original form, and then the effects of three and six years of exposure respectively.

U-bolt decay – also not good

Installations close to the sea water are particularly vulnerable, as salt laden air will accelerate the corrosion process.

There are two fundamental approaches to overcome the impacts of antenna corrosion. Best practise is to use stainless steel bolts, fittings and cables wherever possible.

The alternative is to coat vulnerable fittings with spray paint or a specialised coating.

Stainless steel is not cheap. It is perhaps two to three times the price of its zinc or cadmium plated counterpart, but the extra cost is worth it. There have been times I had winced at this additional cost, but I have never regretted using stainless steel fixtures where metallic assemblies are exposed to the elements.

Suburban hardware stores sell stainless steel parts at a premium price. Better value will be obtained by shopping at a dedicated bolt bar or reseller. At the beginning of a project, work out what bolts and accessories are needed, then email the list to a bolt-bar distributor.

Small boxes of stainless hardware can be delivered to your home for the price of just a few select items in a blister pack from a local hardware store.

Quality Stainless Steel fittings – preferred option

The use of a protective coating to safeguard fittings is not as effective as stainless steel components, but sometimes it's the only choice.

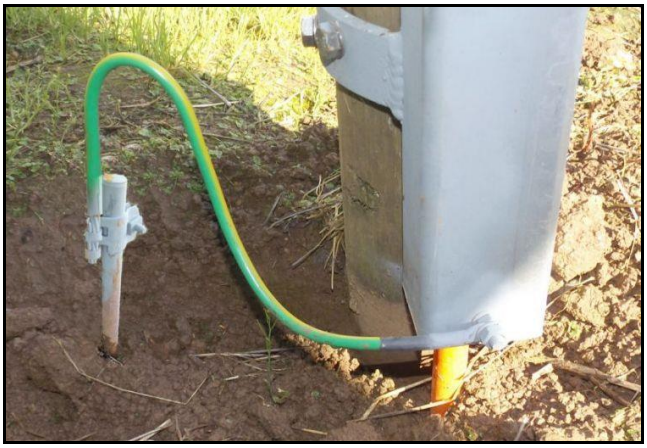
Spray fixtures and bolts wherever assemblies meet. A plain black paint, or a grey cold-galvanising spray is preferred, as these compounds have greater ultraviolet stability.

There is a special clear preparation called '**weather guard'** manufactured in the USA, designed specifically for coating antennas in marine and beachfront settings. It is distributed in Australia through **Andrews Communications** in Sydney.

Mosley Weather-Guard (and DX gell)

The aim is to keep air and water from the junctions between dissimilar metals.
Ultimately, any paint is better than no paint if a quality anti-corrosion coating is unavailable.

Apply a coating to the point where earthing cables connect to an earth stake. Fixtures close to the soil are subject to high humidity and this will accelerate corrosion.



Painted earth connections

Replacement antenna plastics

Second-hand antennas can be great value, but the plastics may have degraded over time. Plastic caps that seal the ends of antenna traps are often worn or damaged. Air-spaced chokes and coils need good seals to ensure reliability.

If the manufacturer is still in business, you may be able to track down the genuine part, however short sections of heat-shrink are a reasonable substitute.

The next image shows 40mm heat-shrink sleeve being applied to a HF trap with a gas-powered heat gun.

Replacing trap protection with heat-shrink

Note that antenna traps for horizontal antennas all have water drainage holes on one side. Oriented these to face the ground or they become a means of filling the trap with water, rather than draining it.

Acquiring large diameter heatshrink for antennas from your retail supplier is not easy, but 1.2 metre sections are available from electrical wholesalers like **Middendorp** and **Rexel**.

Some varieties of heat-shrink have integral hot-melt glue on the inside, which provides an excellent seal, but it makes extra work if this layer ever needs to be removed.

When servicing or repairing antennas such as Log Periodic arrays, getting the right spacers to insulate feedline straps can be difficult.

Some success has been achieved using a hot-air gun to slightly re-shape the plastic chairs designed for holding up steel reinforcement in concrete.

Making do with available components

Sealing coaxial connections

Effective waterproofing of all joins is critical.

Electrical tape on its own is not good enough. Tape degrades in the weather and can end up retaining a lot of water.

There are some great products available for sealing connections, like the Nitto Self Amalgamating tape. It not sticky like regular tape, but binds to itself very well. This one is available from **Altronics** for under $20.

T2951 • Nitto 19mm X 10m Self Amalgamating Tape No.15

There are other products that were not originally intended for outdoor use, but still offer a high level of protection.

Common adhesive products intended for attaching posters to interior walls can be surprisingly effective as a moisture barrier. Supplemented with electrical tape it can be an effective moisture barrier for many years.

To open the join, a knife can be pared vertically along the seal revealing clean, dry connectors.

The video clip below demonstrates this method.

If the outer sheath of a coax cable has been damaged and the braid is visible, it must be sealed and protected. Once water enters coax cable, capillary action can cause the moisture to penetrate several metres in each direction.

Any water affected cable should be replaced. Apart from the corrosion that breaks down the copper braid, , water changes the characteristic impedance and attenuation factors of the cable.

Compromised cable may pass a simple DC continuity test, but power losses will be particularly noticeable at VHF and UHF frequencies.

Effects of Ultraviolet light

UV radiation is especially high in Australia and is one of the main sources of degradation to antenna feedlines.

Anything coloured red will rapidly fade when exposed to sunlight. The molecule that gives light reflections that we interpret as red is complex and ultraviolet radiation breaks down the chains that hold it together.

Black is a less complex molecule and survives much better in sunlight. For this reason, all cable ties used should be stainless steel or black UV stable plastic.

White ties will not last more than a year with full daylight exposure and will begin to crumble with any movement.

Cable ties: use the black ones

Selecting coax cables

Antenna feedlines are a field of study on their own. This section is limited to some essential aspects that are aimed at assisting less experienced amateurs.

Selecting the right cable is important. The cables should always match the application. Low-spec cables may be inappropriate for VHF and UHF. Conversely, it can be wasteful to use a high-spec quality UHF cable on HF bands.

All feedlines have losses which vary with cable length and the frequency.

Selection of Coax Cable

The most common thin coax cable is **RG58**. It is 5mm in diameter and comes in variants with solid and multi-strand centre cores and different braid densities. It is thin enough to use in mobile environments and relatively inexpensive.

It is also fine for most HF applications and adequate on VHF for short cable runs, but losses on UHF are significant.

The common heavy cable with lower losses is **RG8** and its variant **RG213**. This is 10mm in diameter and about two to three times more expensive than RG58. It is a good choice on VHF and adequate on UHF. Unless the cable length is extremely long, it is probably overkill for most HF applications.

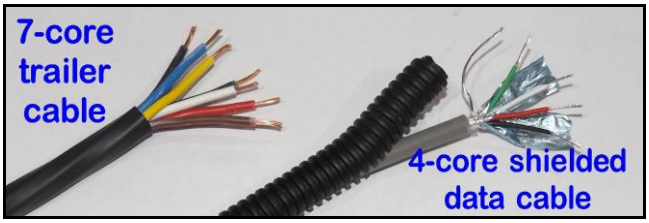
There is a lower-loss alternative to the RG213 called **9913**. From the outside it looks the same 10mm in diameter, but it has a solid centre core and a thin foil layer under the copper braid. It is about twice the price of RG213, but energy loss on the 70cm band is around 30% lower. This makes it an excellent choice for UHF. However, it is can degrade if flexed too often. This lack of flexibility makes it a poor choice for telescoping towers and loop-sections feeding vertical poles above antenna rotators.

A reasonable compromise for UHF antennas is to install low-loss 9913 cable from the shack to the first stage of the tower, or just below a rotator, then swap to the more flexible RG213 for the remainder of the cable run.

Rotator & Control cables

Different brands of antenna rotators use varying numbers of wires to provide control functions; usually between five and eight conductors. These conductors must be thick enough to ensure sufficient current flow to the rotator.

Where possible, I recommend seven-core trailer cable for rotator control. A good supplier is **Radio Parts** in Melbourne. If only a few conductors are needed for say, a mast-mounted coax relay, or an antenna tuner, then the smaller four-core shielded data cable is generally satisfactory.



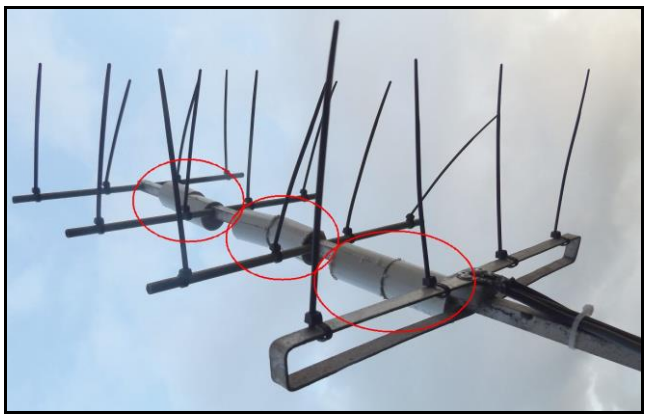
Suitable rotator cable

If the available cable is not ultraviolet stable, it can be protected by placing it in a split-conduit sleeve (shown above). This inexpensive cable protection is available in a range of sizes from most auto parts suppliers.

Protection from birds

Birds can give antenna systems a hard time. The largest culprits are the parrot family, such as cockatoos, galahs and corellas. Even if they don't bother the antennas directly, they can still leave their mark on the roof of the shack.

The image to the right illustrates an effective deterrent to most birds; cable ties attached to the antenna elements. During rain, wet ties may have a small detuning effect on the antenna, but the water drains almost immediately, and the ties become electrically transparent again.



Deterring birds

Also, in this picture, the antenna has short sections of PVC conduit added to the boom. (circled in red) These have been slit so that they can clip over the boom without dismantling the antenna.

Birds avoid these rings, as when they land, they immediately fall sideways. It is a cheap and effective deterrent.

There are chemical alternatives available that will deter birds, like this gelatinous product called Hot Foot. It is non-toxic but birds do not like it.

HOT FOOT REPELLENT BIRD GEL

Hot Foot bird repellent gel has been on the world market for over 40 years and its formula is totally unchanged from when it was first developed. Proven and guaranteed to work, it will repel large numbers of birds from their roosts instantaneously. The unique spray coating called crystal coat protects the underlying gel from absorbtion by dust and dirt thereby extending its economic life by years and years. Hot Foot Gel is the number one proven performing bird gel on the market. Only Hot Foot repellent gel has withstood the test of time and gives proven long term protection against all types of birds to stop roosting and nesting. Sticky enough to cause panic in the birds and for them to emit distress signals that scare other birds away but not too sticky that they get stuck. No bird entanglement, no damage to the bird but the flock is gone.

FOUR PACK OF HOT FOOT REPELLENT GEL

SKU: FP

4 x 10.5oz cartridges of gel and 1 x 14oz of aerosol crystal coat.

STARTING AT $110.00

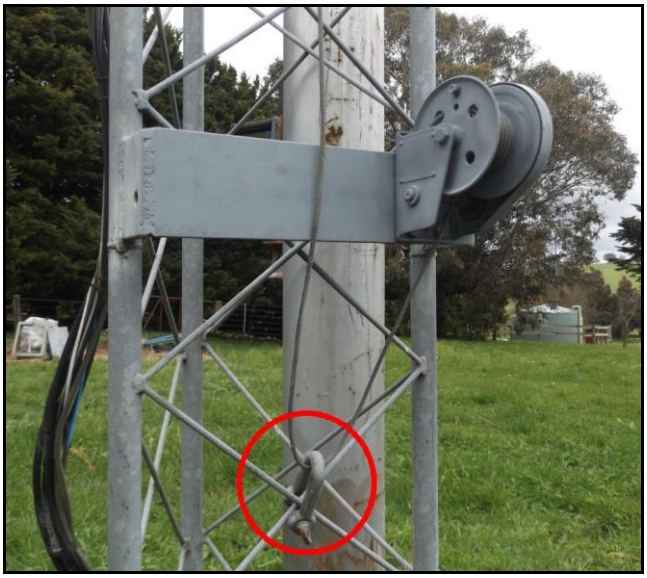
HOTFOOT BIRD REPELLENTS

Winch cables

Most winches come with cheaper galvanised cable, which will last for many years if it is kept dry.

A good strategy to mitigate unwanted moisture is to ensure that the cable never goes straight up from the winch. Water running down the cable will keep the cable drum wet, even in light rain.

When not in use, pull the winch cable down and secure the cable below the winch with a D-shackle as shown in the image below.



This also makes it possible to put a bag over the winch and provide further weather protection.

Consider using a Brake Winch rather than a cheaper Boating Winch. Brake Winches are far safer for tower and mast applications..

The winch handle can be released at any time, without the top stage of a mast running out of control. Quite a few amateurs have suffered cuts and broken arms trying to grab out-of-control winch handle. This makes the additional expense of a good Brake Winch a cheap and preferred form of health insurance.

Summary

There is a lot of information here that may be useful over time. Many Amateurs have their own favourite methods to overcome the challenges of effective antenna installations.

The intention here is to provide a starting point for less experienced amateurs.

Having sound antenna and feedline design, product selection and installation is just as important as sitting down behind the radio.

It is also rewarding to know your new antennas and feedlines shouldn't need maintenance or repair for a very long time.

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Clear Channel Medium Wave Broadcast Stations in Australia

By Glenn VK4DU

The Medium Wave (MW) broadcast band

The MW broadcast band in Australia runs from 526.5 to 1606.5 kHz. In practice, the lowest and highest channels are 531 and 1602 kHz respectively. Channel spacing is 9 kHz.

Although many stations have migrated to VHF FM over the past few decades, the MW band is still used extensively across the country. There are a limited number of channels available, so some sharing between stations is required.

Geographic separation and directional antennas are used to reduce interference between stations sharing a channel.

Clear that channel

A few of the ABC transmitters have large service areas, so they have been assigned their own dedicated channel.

These are known as "clear channel" transmitters in broadcast parlance; they can be received over a wide service area with no interference from other stations.

It's not all about the watts

Most commercial stations run between 2 and 5 kW output power. ABC transmitters in capital cities and some regional areas operate at up to 50 kW.

MW broadcast stations are rated by field strength, rather than transmitter power. MW station field strength is expressed as Cymomotive Force (CMF).

CMF is measured in volts and is a product of antenna efficiency and transmitter power.

The big guns

The two Australian stations with the most powerful signals – i.e., the highest licenced field strength, are 3LO in Melbourne (774 kHz) and 2BL in Sydney (702 kHz); otherwise known as ABC Radio Melbourne and Sydney.

Both of these stations use 50kW transmitters feeding 200m high mast antennas.

Although 2BL is technically not a clear channel station – it shares the channel with Karratha, WA – its signals, like those of its southern counterpart, are very strong on the eastern seaboard.

You can receive 2BL north of Melbourne and 3LO south of Sydney on your car radio, in daylight…. At night, 2BL can be received driving around Cairns.

Some other clear channel stations with big signals are:

- Horsham 3WV 594 kHz
- Emerald 4QD 1548 kHz
- Adelaide 5RN 729 kHz
- Sydney 2RN 576 kHz (same tower as 2BL, slightly lower field strength)

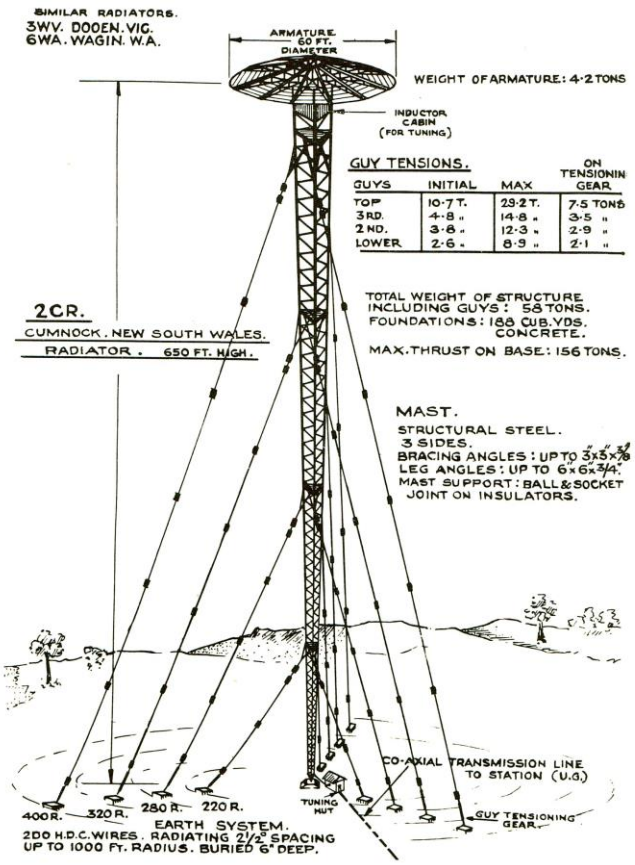
The ABC station at Cumnock, 2CR (549 kHz), between Wellington and Molong in western NSW is not far behind the two big guns in field strength – it is audible all over NSW and parts of Qld and Vic in daylight.

2CR commenced operation in 1935.

The ABC produced a good video of the Cumnock site recently:

Because of the low frequency of operation, the 2CR antenna uses a capacity top hat to provide extra electrical length.

See the drawing overleaf.



2CR antenna details, Australian Post Office, 1951

For a more detailed picture – click this link

International DX

The Sydney station 2BL has been received by DX'ers in the US – click this link for a video.

3LO Melbourne shares 774 kHz with a New Zealand station in New Plymouth.

If you are outside VK3, you can hear the ZL station under 3LO at dusk and at night….but you do need a decent receiver and antenna.

The guide

ACMA publish the best reference for Australian broadcasting stations.

The official list of Australian broadcast stations is available as a downloadable excel spreadsheet. It covers all broadcasting – AM, FM, Digital Audio Broadcasting (DAB) and TV stations.

An oldie but a goodie

MW broadcast radio is very much the poor relation in this age of internet streaming and DAB.

The ABC seem almost reluctant to promote their AM transmitters….the AM frequency always comes last in station announcements…

Despite this, MW broadcasting will be with us for some time yet – no other technology covers rural and regional Australia like good old *Medium Wave*….static crashes and all…

Happy DX-ing.

Radio & Electronics School
Established 1997

Radio Theory Handbook – Beginner to Advanced

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Chapters 1 and 2.

http://members.iinet.net.au/~ronber/ (book preview, review and purchase options)

Chapter 1 - BASIC ELECTRICITY I

This book begins with the basics of electrical and radio theory and then progressively builds to a solid understanding of Advanced Amateur Radio operator level as it applies to Australia, U.K. USA, Canada and Europe. While starting at beginner level, the target standard of this book is CEPT Radio Experimenter Advanced Licence (T/R61-01) and higher. It is imperative to have a thorough understanding of the fundamentals of electricity before any study of radio and communications. We start our study from the beginning, thus benefiting readers with a limited knowledge of the basics whilst also providing a convenient refresher for those who may have long since covered the material. Once we have the fundamentals down rock solid, we will progress to the Advanced Radio Theory.

ELECTRICITY

The complicated electronic systems involved in modern day communication, satellites, nuclear power plants, radio and television and even up to date automobiles, do not require technicians to understand the functioning of electric and electronic circuits. Modern day electronics is very modular. A remove and replace, or substitution of the suspected 'faulty module' is the approach to modern electronics servicing. This, in itself, is not a bad thing, as in the real world, getting an electronic device up and going is the most important thing. However, to have a true understanding requires a strong foundation in the basics of electricity.

The term "electronic" infers circuits ranging from the first electronic device, the electron tube, to the newer solid state devices such as diodes and transistors, as well as integrated circuits (ICs). The term "electric" or "electrical" is usually applied to systems or circuits in which electrons flow through wires but which involve no vacuum tubes or solid state devices. Many modern electrical systems are now using electronic devices to control the electric current that flows in them.

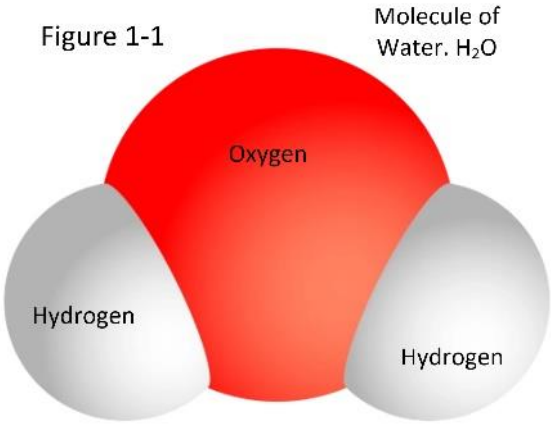
What makes such a simple thing as an electric lamp glow? It is easy to pass the question off with the statement, "The switch connects the light to the power lines and it glows" or something to that effect. But what does connecting the light to the power lines do? How does energy travel through solid copper wires? What makes a motor turn? A radio play? What is behind the dial that allows you to pick out one radio station from thousands of others operating at the same time? How fast is electricity? There are no single, simple answers to any of these questions. Each question requires the understanding of many basic principles. By adding one basic idea to another, it is possible to answer, eventually, all of the questions that may be asked about the intriguing subjects of electricity, electronics and radio.

When a light switch is turned on and elsewhere the light suddenly glows, energy has found a path through the switch to the light. The path used is usually along copper wires and the tiny particles that do the moving and carry the energy are called electrons. These electrons are important to anyone studying electronics and radio since they are usually the only particles that are considered to move in electric circuits.

To explain what is meant by an electron, it will be necessary to investigate more closely the make-up of all matter. The word "matter" means, in a general sense, anything that can be touched. It includes substances such as rubber, salt, wood, water, glass, copper and air. The whole world is made of different kinds of stuff. The ancient Greek philosophers were always trying to find the 'stuff' that made up the universe. Even before the Greeks, the Alchemists were trying to find the basic building blocks that all matter was made from, though most of the time their driving force was not so much science but the pursuit of wealth. They figured that if they could isolate the building blocks of matter, then they would be able to 'create' matter themselves. One of their primary pursuits was the creation of the precious metal gold.

Water is one of the most common forms of 'stuff' that we call matter. If a drop of water is divided in two and then divided again and again until it can be divided no longer and still be water, then we have arrived at the smallest possible piece of water. We have a water molecule. The ancient Greeks would have called the smallest droplet of water an atomos (atom). The word atomos means indivisible. We know today that substances such as water can be divided into more fundamental bits.

Figure 1-1



The water molecule can be broken down into still smaller particles, but these new particles will not be water. Physicists have found that three smaller particles make up a molecule of water. Two atoms of hydrogen (H) and one atom of oxygen (O) are shown in figure 1-1. The symbols 'H' and 'O' are universal symbols used to represent Hydrogen and Oxygen. Oxygen, at average temperatures, is one of the several gases that constitute the air we breathe. Hydrogen is also a gas in its natural state; it is found in everyday use as part of the gas used for heating or cooking.

If a gaseous mixture containing two parts of hydrogen and one part of oxygen is ignited, a violent chemical reaction, an explosion, will occur as water is formed and excess energy released. This is not an experiment that I would recommend.

Water is made up of two types of atoms, hydrogen and oxygen. Water is a molecule. A molecule is a substance that is made up of groups of atoms. If you divided a droplet of water down to its smallest possible size, you would have a single molecule of water. If you had the means to split the water molecule further, you would no longer have water; you will have the atoms (hydrogen and oxygen) that make up water. The chemical name of water then is Dihydrogen Oxide. It has been found that atoms are also divisible. An atom is made up of at least two types of particles: ***protons*** and ***electrons*** and a third particle called a ***neutron***. Don't let these names concern you too much. For our purposes, the primary particle is the electron. Electrons and protons are called electrical particles and neither one is divisible (in typical environments). All the molecules that make up all matter in the universe are composed of these electrical proton-electron pairs.

ELECTRONS AND PROTONS

Electrons are the smallest and lightest of the fundamental particles. They are said to have a negative charge, meaning that they are surrounded by an invisible force field that will react in an electrically negative manner with other matter.

Protons are said to have a positive charge and are surrounded by an invisible force field that causes them to react in an electrically positive manner. The words negative and positive are just names to describe the so called charge of electrons and protons and their charge describes how they interact with each other. We could just as easily call the charge of the electron the white charge and the charge of the proton the black charge. My point is, 'charge' is an electric behaviour and since there are two types of charge we need to name them so that when we talk about them we will know which behaviour we are speaking of: either the positive charge behaviour or the negative charge behaviour.

AN EXPERIMENT WITH CHARGE

You may have already done this if you have, please try it again. Tear up some tiny strips of paper and place them on the table in front of you. Make sure no one is watching! Now run a hair comb through your hair briskly several times and put the comb close to the bits of paper. Before the comb touches the paper, a bit of paper will leap off the table, move through the air and cling to the comb. This happens because you have produced a charge on the comb, which will physically interact with matter around it (in our case the bits of paper).

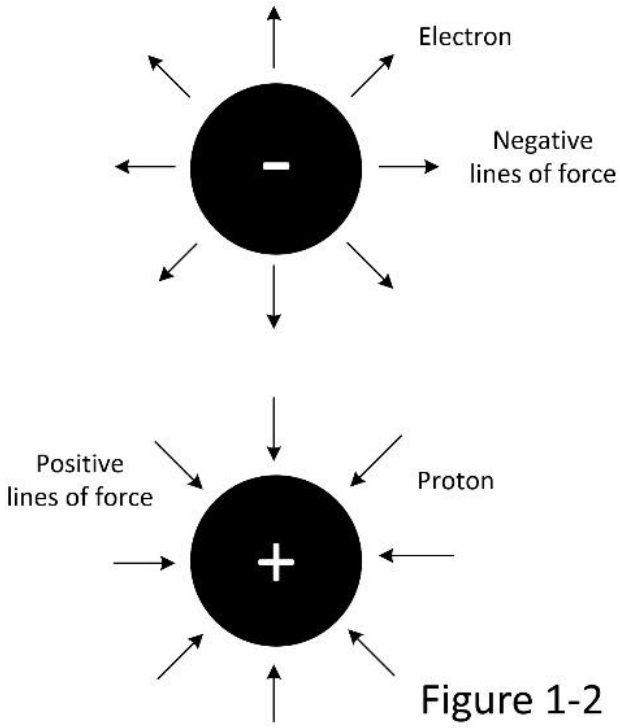


Figure 1-2

The charge on the comb was created by friction between the comb and your hair. Protons are about eighteen hundred times more massive than electrons and have a positive electric field surrounding them.

The proton is exactly as positive as the electron is negative; each has a unit of electric charge.

When an electron and a proton are far apart, only a few of their lines of force (the invisible field around them) join and pull together. The attracting pull between the two charges is, therefore, small. When brought closer together, the electron and proton can link more of their lines of force and will pull together with greater force. If close enough, all the lines of force from the electron are joined to all the lines of force of the proton and there is no external field and they attract each other strongly. Together, a positive charged proton and the negative charge of an electron cancel out and they form a neutral, or uncharged, group. The neutral atomic particle, known as a neutron, exists in the nucleus of all atoms heavier than hydrogen. The fact that electrons repel other electrons, protons repel other protons, but electrons and protons attract each other gives us the basic law of charges:

LIKE CHARGES REPEL, UNLIKE CHARGES ATTRACT

Because the proton has about 1,800 times more mass than the electron, it seems reasonable to assume that when an electron and a proton attract each other, it will be the lower mass and free to move electrons that will do most of the actual moving. Such is the case. It is the ***electron*** which moves in electricity. If the proton was the lower mass particle and not in the nucleus, we would probably have called what we know today as 'electricity', something like 'proton'icity. Regardless of the difference in apparent size and mass, the negative field of an electron is just as strong negatively as the positive field of a proton is positive.

Though physically small, the field near the electron is quite strong. If the field strength (field strength = the strength of the invisible field) around an electron at a distance of one millionth of a metre is a certain amount, at two-millionths of a metre it will be one quarter as much; at four millionths of a metre it will be one-sixteenth as much; and so on. If the field decreases as distance increases, the field is said to vary inversely with distance. It varies inversely with the distance squared.

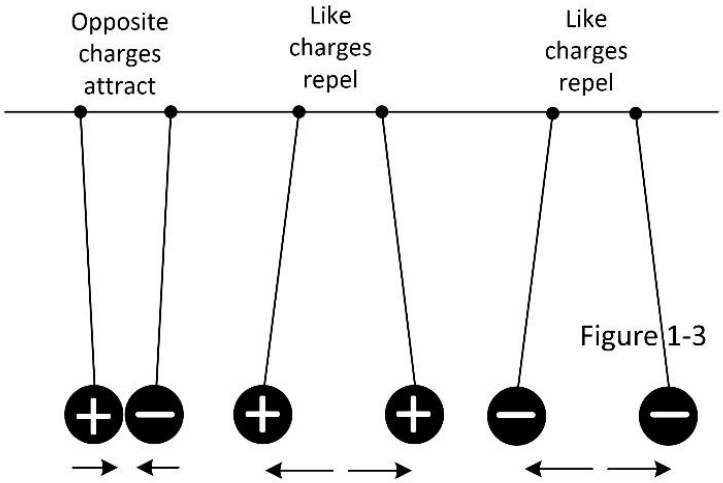


Figure 1-3

Note: A millionth of a metre has a name; it is called a 'micron'. A micron is not an *International System* (SI) Unit, but it is a unit which has stuck and is still often used. It is too nice of a name not to be used.

When an increase in something produces an increase in something else, the two things are said to vary directly rather than inversely. Two million electrons on an object produce twice as much negative charge as one million electrons would. The charge is directly proportional to the number of electrons. The invisible fields surrounding electrons and protons are known as electrostatic fields. The word 'static' means, in this case, "stationary', or "not caused by movement", When electrons are made to move, the result is dynamic electricity.

The word "dynamic" indicates that motion is involved. To produce a movement of an electron, it will be necessary to have either, a negatively charged field to push it, or positively charged field to pull it. Normally in an electric circuit, both a negative and a positive charge are used (a pushing and pulling pair of forces).

THE ATOM AND ITS FREE ELECTRONS

As of 2019 there are 118 different kinds of atoms, or elements, from which the millions of different forms of matter found in the universe, are composed. Let me elaborate on the last paragraph. About 100 different atoms are found in nature. Many atoms do not occur naturally. Many are only manufactured in very powerful particle colliders or inside stars.

The heavy atoms, those containing a large number of protons, electrons and neutrons, like uranium and radium are unstable. They throw off energy (they are radioactive) and decompose until they become stable non-radioactive atoms. A material, which is only made from one type of atom, is called an element. Water is not an element because it contains two types of atoms, hydrogen and oxygen. Water is, therefore, a molecule. Copper contains only copper atoms, so copper is an element. There are many other common elements.

The simplest and lightest atom (or element) is hydrogen. An atom of hydrogen consists of one electron and one proton, as shown in figure 1-4. In one respect the hydrogen atom is similar to all others: the electron whirls (orbits) around the proton, or nucleus, of the atom, much as planets rotate around the sun. Electrons whirling around the nucleus are termed planetary, or orbital, electrons! This is not an accurate model but is accurate for our purposes in radio physics. Electrons are more like clouds around the nucleus with electrons having a probability that they are more likely to be in the vicinity of one or more bands. We really can't say that they are just like planets around the sun, however we can use this analogy for our purposes.

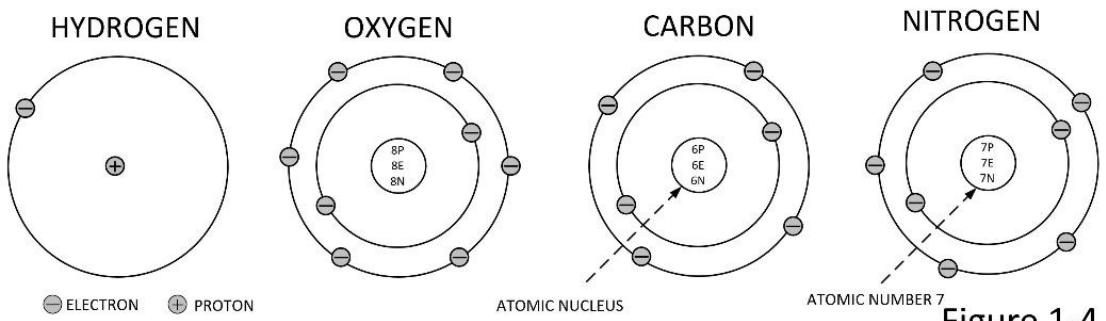
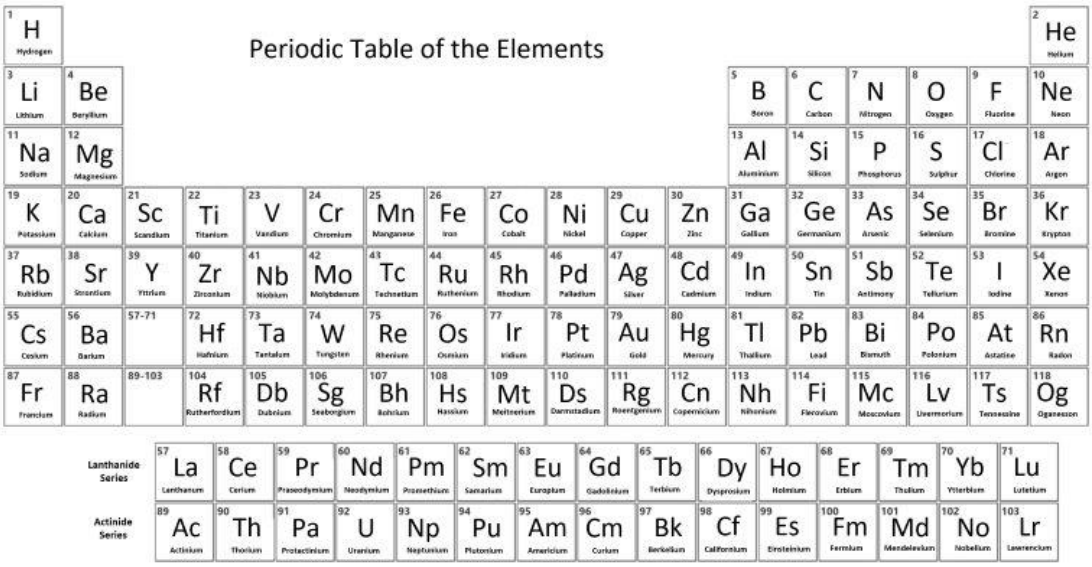


Figure 1-4

The nucleus is just a name given to the 'centre' of an atom. The next atom in terms of atomic weight is helium, having two protons and two electrons. The third atom is lithium, with three electrons and three protons and so on. All elements are grouped in families with the atomic weights in the Periodic table of elements.

Most atoms have a nucleus (centre) consisting of all the protons of the atom and also one or more neutrons. The electrons (always equal in number to the protons in the nucleus) are whirling around (orbiting) the nucleus in various layers. The first layer of electrons outside the nucleus can accommodate only two electrons. If the atom has three electrons, two will be in the first layer and the third will be in the next layer. The second layer is completely filled when eight electrons are whirling around in it. The third is filled when it has eighteen electrons. Some of the electrons in the outer orbit, or shell, of the atoms of many materials such as copper or silver, exist in a higher "conduction level" and can be dislodged easily. These electrons travel out into the wide open spaces between the atoms and molecules and may be termed free electrons.



Other electrons in the outer orbit will resist dislodgement and are called bound or valence electrons. Materials consisting of atoms (or molecules) having many free electrons will allow an easy interchange of their outer shell electrons while atoms with only bound electrons will hinder any electron exchange. Copper, for example, has one electron in its outer orbit or layer.

This lonely little outer electron of the copper atom is very easy to 'steal' from the copper atom and made to move. The outer electron is called a ***free electron***. It is not free but loosely bound to the atom and easy to encourage away and made to move, so we call it a free electron. Copper does not resist the movement of its outer electrons strongly, or in other words, it does not offer much resistance to us if we try to get its outer electrons to move. We will talk about how we get them to move later. A material, which does not have free electrons, is said to have a high resistance. All metals have free electrons. Most common metals when heated cause greater energy to be developed in their free electrons. The more energy electrons have the greater they resist orderly movement through the material. The material is said to have an increased resistance to the movement of electrons through it.

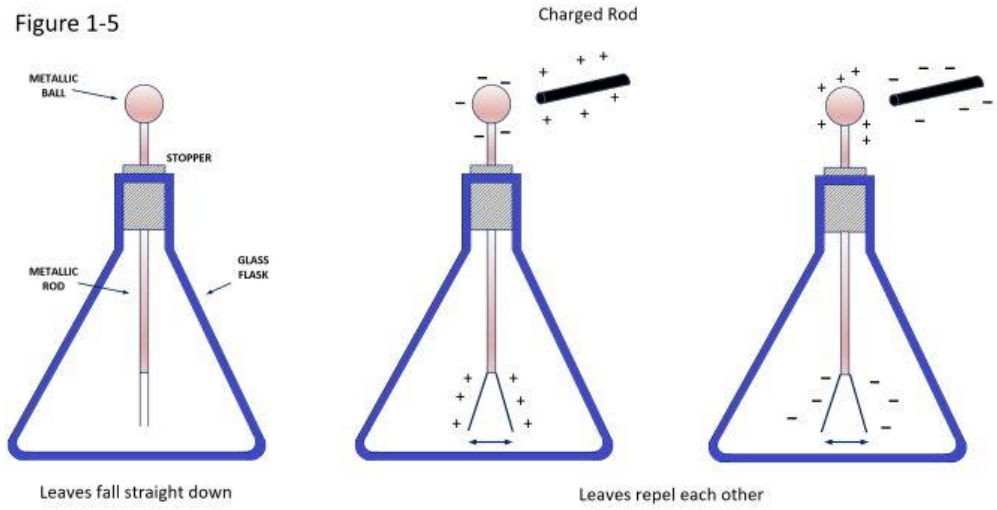
THE ELECTROSCOPE

The charge on the comb was created by friction between the comb and your hair. Protons are about eighteen hundred times more massive than electrons and have a positive electric field surrounding them.
An example of electrons and electric charges acting on one another is demonstrated by the action of an electroscope. An electroscope consists of two very thin gold or aluminium leaves attached to the bottom of a metal rod. The delicate metal foil leaves and rod are encased in a glass bottle to protect them from air movement.
To understand the operation of the electroscope, it is necessary to recall these facts:

1) Normally an object has a neutral charge.
2) Like charges repel; unlike charges attract.
3) Electrons are negative.
4) Metals have free electrons.

Normally the metal rod of the electroscope has a neutral charge and the leaves hang downward parallel to each other, as shown in figure 1-5A. The leaves are shown in charged position in figure 1-5B and 1-5C. With no charge the leaves hang vertically down from the rod.

Figure 1-5



Rubbing a piece of hard rubber with wool causes the wool to lose electrons to the rubber and the excess electrons on the rubber, charge the rubber negatively. When such a negatively charged object is brought near the top of the rod, some of the free electrons at the top are repelled and travel down the rod, away from the negatively charged object. Some of these electrons force themselves onto one of the leaves and some onto the other. Now the two leaves are no longer neutral but are slightly negative and repel each other, moving outward from the vertical position as shown. When the charged object is removed, electrons return up the rod to their original areas. The leaves again have a neutral charge and hang down parallel to each other.

Since the charged object did not touch the electroscope, it neither placed electrons on the rod nor took electrons from it. When electrons were driven to the bottom, making the leaves negative, these same electrons leaving the top of the rod left the top positive. The overall charge of the rod remained neutral. When the charged object was withdrawn, the positive charge at the top of the rod pulled the displaced electrons up to it. All parts of the rod were then neutral again. If a positively charged object, such as a glass rod vigorously rubbed with a piece of silk, is brought near the top of the electroscope rod, some of the free electrons in the leaves and rod will be attracted upward toward the positive object. This charges the top of the rod negatively because of the excess of free electrons there. Both leaves are left with a deficiency of free electrons which means they are positively charged. Since both leaves are similarly charged again, they repel each other and move outward a second time.

A deficiency of electrons on an object leaves the object with a positive charge. An excess of electrons gives it a negative charge. If a negatively charged object is touched to the metal rod, some excess electrons will be deposited onto the rod and will be immediately distributed throughout the electroscope. The leaves spread apart. When the object is taken away, an excess of electrons remains on the rod and the leaves. The leaves stay spread apart. If the negatively charged electroscope is touched to a large body that can accept the excess free electrons, such as a person, a large metal object, or earth (the ground), the excess electrons will have a path to leave the electroscope and the leaves will collapse as the charge returns to neutral. The electroscope has been discharged. If a positively charged object is touched to the top of the metal rod, the rod will lose electrons to it and the leaves will separate. When the object is taken away, the rod and leaves still lack free electrons and are therefore positively charged and the leaves will remain apart.

A large neutral body touched to the rod will drain some of its free electrons to the electroscope discharging it and the leaves will hang down once more. The electroscope demonstrates the free

movement of electrons that can take place through metallic objects or conductors when electric pressures, or charges, are exerted on the free electrons.

Chapter 2 - BASIC ELECTRICITY II

THE THREE BIG NAMES IN ELECTRICTY

Without calling them by name, we have touched on the three elements always present in operating electric circuits:

Current: A progressive movement of free electrons along a wire or other conductor caused by electrical pressure.
Voltage: The electron moving force in a circuit that pushes and pulls electrons (current) through the circuit. Also called electromotive force and electrical pressure.
Resistance: Any opposing effect that hinders free electron progress through wires when an electromotive force is attempting to produce a current in the circuit.

We will be talking a lot about these three properties of an electric circuit and how they relate to each other.

A SIMPLE CIRCUIT

The simplest of electric circuits consists of some electron moving force, or source, such as that provided by a dry cell, or battery, and a load, such as an electric light, connecting wires and a control device. A pictorial representation and the electric diagram of a simple circuit is shown in figure 2-1.
The diagram in figure 2-1 is called a schematic diagram and is much easier to draw. The control device is a switch, to turn the bulb ON and OFF. In effect, the switch disconnects one of the wires from the cell. In our circuit, the switch could be connected anywhere to turn the bulb ON and OFF. In this circuit, the light bulb is the load. Although the wires connecting the source of electromotive force (the dry cell) to the load may have some resistance, it is usually tiny in comparison with the resistance of the load and is ignored in most cases.

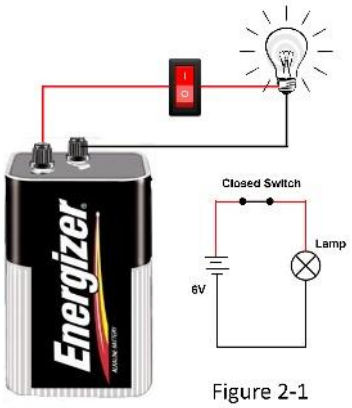


Figure 2-1

A straight line in a schematic diagram is considered to connect components electrically and does not represent any resistance in the circuit. In the simple circuit shown, the cell produces the electromotive force (voltage) that continually pulls electrons to its positive terminal from the bulb's filament and pushes them out of the negative terminal to replace the electrons that were lost to the load by the pull of the positive terminal. The result is a continual flow of electrons through the lamp filament, connecting wires and source. The special resistance wire of the lamp filament heats when a current of electrons flows through it. If enough current flows, the wire becomes white hot and the bulb glows and gives off light (incandescence).

CURRENT

A stream of electrons forced into motion by an electromotive force is known as a current. Here we have a definition of electric current:

Current is the ordered movement of electrons in a circuit

In a good conducting material such as copper, one or more free electrons in the outer ring are constantly flying off at a high rate. Electrons from other nearby atoms fill in the gaps. There is a constant aimless movement of billions of electrons in all directions at all times in every part of any conductor. This random movement of electrons is not an electric current, as there is not yet movement in any one direction.

Only when a voltage is applied, do we get an ordered movement of electrons. When an electric force is applied across the conductor (from a battery), it drives some of these aimlessly moving free electrons away from the negative force toward the positive. It is unlikely that any one electron will move more than a fraction of a centimetre in a second, but an energy flow takes place along the conductor at a significant fraction of the velocity of light .

Notice that I said the energy flow in the circuit is very fast (almost the speed of light - but not quite). The speed of the electrons in a circuit - or the current flow is in fact very slow. I won't bore you with calculations. However, I did once calculate how fast the electron flow was in a typical circuit and it came to be about walking speed. Electron flow or current flow is very slow. The effect of an electric current at a distance through a conductor, on the other hand, is very fast.

If you have trouble with this and many do, think about how fast water travels through a pipe. The dam where the water comes from may be many kilometres away from the tap. When you turn the tap on the water comes out immediately does it not? Did the water travel all the way from the dam to the tap in an instant? I am sure you would agree that it did not. If I tried to tell you that it did you would most probably laugh at me and say the water was already in the pipe, all you did by turning the tap on was to make the water move in the pipe between the dam and the tap.

Similarly, the electrons are already in the wire (conductor). When we close a switch in the circuit and apply an electromotive force, all we are doing is making all the electrons move in the conductor at the same time. It may take a very long time for an electron leaving the source to reach the load if it ever does.

HOW FAST ARE MARBLES?

Let's do another analogy to make sure we have got this clear. Suppose a pipe was connected between Sydney and Melbourne. Imagine if we blocked off one end of the pipe and filled it with marbles until we could not fit any more in. We now unblock the pipe and we have a crowd of people at each end to witness the experiment and find out how fast marbles travel. The two crowds are in contact by telephone or radio and anxiously awaiting the big moment. One too many marbles is about to be inserted into the full pipe. As soon as a marble is inserted in Sydney, a marble drops out in Melbourne. The effect of pushing a marble into the pipe in Sydney caused an immediate result or effect in Melbourne. The newspaper's report "Eccentric experimenter proves that marbles travel at the speed of light". Is this right?

I hope you are shaking your head and saying 'no'. The marble, which fell out of the pipe in Melbourne, was sitting there ready to fall out as soon as the marble was pushed in at the Sydney end. So, marbles definitely do not travel at the speed of light any more than do electrons in a conductor. The marbles were already in the pipe just as the electrons were already in the conductor.

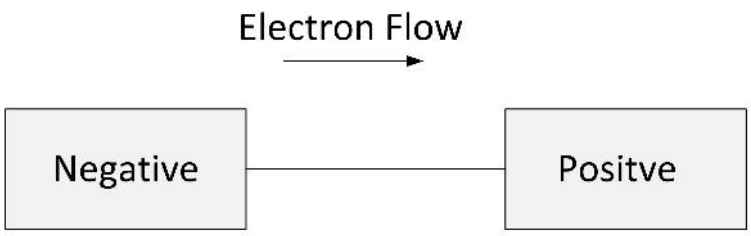
The effect of an electric current at a distance is almost instantaneous; however, the speed of the electrons is very slow.
A source of electrical energy does not increase the number of free electrons in a circuit; it merely produces a concerted pressure on loose, aimlessly moving electrons. If the material of the circuit is made of atoms or molecules that have no freely interchanging electrons, the source cannot produce any current in the material. Such a material is known as an insulator, or a non-conductor.

The amount of current in a circuit is measured in Amperes, abbreviated 'A' or Amp. An ampere is a certain number of electrons passing or drifting passed a single point in an electric circuit in one second. Therefore, an ampere is a rate of flow, similar to litres (or marbles) per minute in a pipe. The quantity of electrons used in determining an ampere (and other electrical units) is the Coulomb, abbreviated 'C'. An ampere is one Coulomb per second. A single coulomb is 6,250,000,000,000,000,000 electrons. This large number is more easily expressed as 6.25 x 10^{18}, which is read verbally as 6 point 25 times 10 to the eighteenth power". "Ten to the eighteenth power" means the

ELECTROMOTIVE FORCE OR VOLTAGE

The electron moving force in electricity, variously termed electromotive force (emf), electric potential, potential difference (PD), electric pressure and voltage (V), is responsible for the pulling and pushing of the electric current through a circuit. The force is the result of an expenditure of some form of energy to produce an electrostatic field.

An emf (I like to read this as 'electron-moving force') exists between two objects whenever one of them has an excess of free electrons and the other has a deficiency of free electrons. An object with an excess of electrons is negatively charged. Similarly, an object with a deficiency of electrons is positively charged. Should two objects with a difference in charge be connected by a conductor, a discharge current will flow from the negative body to the positive one.
Instead of writing negatively or positively charged all the time it is easier to say **'-Ve'** or **'+Ve.'** I tend not to use this notation, but you should know what it means.



(A) Figure 2-2 (B)

An emf also exists between two objects whenever there is a difference in the number of free electrons per unit volume of the objects. In other words, both objects may have a negative

charge, but one is more negative than the other. The less negative object is said to be positive with respect to the more negative object.

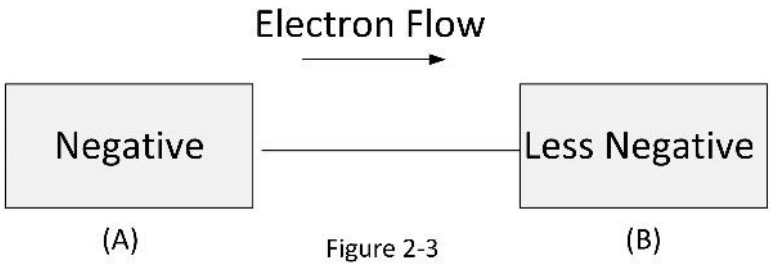


Figure 2-3

In the electrical trades, it is common to hear of current flow from positive to negative. This is called the ***conventional*** direction of current flow. This is just what it says, a convention (popular method). Current flow is electron flow and it is from negative to positive. Conventional current flow is mostly used in Electrical Engineering. In Radio, there is a greater tendency to do what I have done in this book and that is to use ***electron flow;*** current flows from negative to positive.

The unit of measurement of electric pressure, or emf, is the Volt (V). A single torch dry cell produces about 1.5V. A volt can also be defined as the pressure required to force a current of one ampere through a resistance of one ohm.

PRODUCING AN ELECTRON-MOVING FORCE

NOTE: A battery is a collection of cells (like a battery of cannons). There is no such thing as an AA battery; it is an AA cell. On the other hand, a 9 volt transistor battery or a car battery are samples of real batteries because they are constructed from a number of cells connected together (in series).

1) Chemical (cells and batteries).
2) Electromagnetic (generators).
3) Thermal (heating the junction of dissimilar metals).
4) Magnetostriction (filters and special energy converters called transducers).
5) Static (laboratory static electricity generators).
6) Photoelectric (light sensitive cells).
7) Magnetohydrodynamics (MHD, a process that converts hot gas directly to electric current).
8) Piezoelectricity - some materials produce a voltage when physical pressure is applied to them.

EFFECTS OF AN ELECTRIC CURRENT

1) Heat and light - current flowing in a conductor causes the conductor's temperature to increase. If the temperature increases sufficiently, the conductor will become incandescent and radiate light.
2) Magnetic - a conductor carrying a current will produce a magnetic field around the conductor.
3) Chemical - electroplating, charging batteries. An electric current is able to cause a chemical reaction.

THE BATTERY IN A CIRCUIT

In the explanations thus far, "objects," either positively or negatively charged, have been used. A common method of producing an emf is by the chemical action in a battery. Without going into the chemical reactions that take place inside a cell, a brief outline of the operation of a Leclanche cell is given here.
Consider a torch battery. Such a battery (two or more cells form a battery) is composed of a zinc container, a carbon rod down the middle of the cell and a black, damp, paste like electrolyte between them. The zinc container is the negative terminal. The carbon rod is the positive terminal. The active chemicals in such a cell are the zinc and the electrolyte.

The materials in the cell are selected substances that permit electrons to be pulled from the outer orbits of the molecules or atoms of the carbon terminal, chemically by the electrolyte, and be deposited onto the zinc can. This leaves the carbon positively charged and the zinc negatively charged.

The number of electrons that move is dependent upon the types of chemicals used and the relative areas of the zinc and carbon electrodes. If the cell is not connected to an electric circuit, the chemicals can pull a certain number of electrons from the rod over to the zinc. The massing of these electrons on the zinc produces a backward pressure of electrons, or an electric strain, equal to the chemical energy of the cell and no more electrons can move across the electrolyte.

If a wire is connected between the positive and negative terminals of the cell, the 1.5 V of emf starts a current of electrons flowing through the wire. The electrons flowing through the wire start to fill up the deficient outer orbits of the molecules of the positive rod.

The electron movement away from the zinc into the wire begins to neutralise the charge of the cell. The electron pressure built up on the zinc, which held the chemical action in check, is decreased. The chemicals of the electrolyte can now force an electron stream from the positive rod through the cell to the zinc, maintaining a current of electrons through the wire and battery as long as the chemicals hold out.

As soon as the wire begins to carry electrons; the electrolyte also has an electric current moving through it. This motion produces an equal amount of current through the whole circuit at the same time. This is a very important concept to understand. There are no bunches of electrons moving around an electric circuit like a group of racehorses running around a track. A closed circuit is more like the racetrack with a single lane of cars, bumper to bumper. Either all must move at the same time, or none can move. In an electric circuit, when electrons start flowing in one part, all parts of the circuit can be considered to have the same value of current flowing in them instantly. Most circuits are so short that the energy flow velocity, 300,000,000 meters per second, may be disregarded. Figure 2-4 shows the construction of a typical 9V batteries from individual cells.

Figure 2-4

IONISATION

When an atom loses an electron, it lacks a negative charge and is therefore positive. An atom with a deficiency of one or more electrons is called a positive ion. On the other hand, if an atom were to gain an electron, albeit temporarily, it is a negative ion.

In most metals the atoms are constantly losing and regaining free electrons. They may be thought of as constantly undergoing ionisation. Because of this, metals are usually good electrical conductors. Atoms in a gas are not normally ionised to any great extent and therefore, a gas is not a good conductor under low electric pressures.

However, if the emf is increased across an area in which gas atoms are present, some of the outer orbiting electrons of the gas atoms will be attracted to the positive terminal of the source of emf and the remainder of the atom will be attracted toward the negative. When pressure increases enough, one or more free electrons may be torn from the atoms. The atoms are ionised. If ionisation happens to enough of the atoms in the gas, a current flows through the gas. For any particular gas at any particular pressure, there is a certain voltage value that will produce ionisation. Below this value, the number of ionised atoms is small. Above the critical value, more atoms are ionised, producing greater current flow, which tends to hold the voltage across the gas at a constant value. In an ionised condition the gas acts as an electric conductor.

Examples of ionisation of gases are lightning, neon lights and fluorescent lights. Ionisation plays an important part in electronics and radio.

TYPES OF CURRENT AND VOLTAGE

Different types of currents and voltages that are dealt with in electricity:

1. Direct current (DC). There is no variation of the amplitude (strength) of the current or voltage. Supplied from batteries, DC generators and power supplies.
2. Varying direct current (VDC). The amplitude of the current or voltage varies but never falls to zero. Found in many radio and electronic circuits. A telephone is a good example of the use of varying direct current.
3. Pulsating direct current (PDC). The amplitude drops to zero periodically (such as our light bulb circuit if it was repeatedly switched on and off).
4. Alternating current (AC). Electron flow reverses (alternates) periodically and usually changes amplitude in a more or less regular manner.

AC is produced in AC generators, oscillators, some microphones and radios in general. Household electricity is alternating current.

RESISTANCE

Resistance is that property of an electric circuit which opposes the flow of current. Resistance is measured in Ohms. The higher the resistance in an electric circuit the lower the current flow. The symbol used for resistance is the Greek letter Omega - 0. If a circuit with an electric pressure of 1 volt causes a current of 1 Ampere to flow, then the circuit has a Resistance of 10.
What is resistance? It is all well and good to say it is the opposition to current flow but from where does the opposition come? Resistance causes heat. In fact, resistance is the only electrical property that produces heat. Resistance is the effort or energy that it takes to get electrons moving. When we do get them moving some of the energy is dissipated as heat. It is lost energy. So resistance is the energy lost making electrons move in an orderly manner.

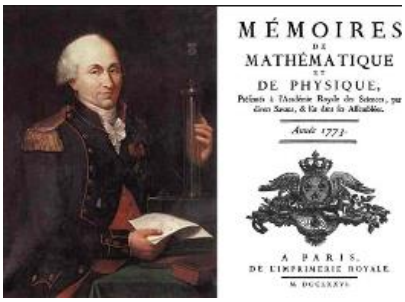
WHATS IN A NAME

We have learned quite a few new terms. Some of these terms are taken from people's names. These people were usually pioneers in the fields of physics, electricity or electronics. Read the very short biographies below and think about the person's name and what it represents in an electric circuit.

George Simon Ohm. Born March 16, 1789, Erlangen, Bavaria [Germany]. Died July 6, 1854, Munich. German physicist who discovered the law named after him, which states that the current flow through a conductor is directly proportional to the potential difference (voltage) and inversely proportional to the resistance.

Andre-Marie Ampere. Born Jan. 22, 1775, Lyon, France. Died June 10, 1836, Marseille. French physicist who founded and named the science of electrodynamics, now known as electromagnetism. Ampere was a prodigy who mastered all mathematics then existing by the time he was 12 years old. He became a professor of physics and chemistry at Bourg in 1801 and a professor of mathematics at the Ecole Polytechnique in Paris in 1809.

Allesandro Giuseppe Antonio Anastasia Volta. Born Feb. 18, 1745, Como, Lombardy [Italy]. Died March 5, 1827, Como. Italian physicist whose invention of the electric battery provided the first source of continuous current. He became a professor of physics at the Royal School of Como in 1774 and discovered and isolated methane gas in 1778. One year later he was appointed to the chair of physics at the University of Pavia.



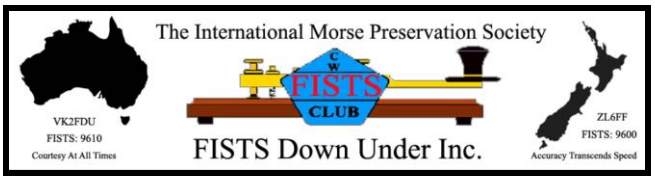
Charles Augustin de Coulomb. Born June 14, 1736, Angouleme, France. Died Aug. 23, 1806, Paris. French physicist best known for the formulation of Coulomb's law, which states that the force between two electrical charges is proportional to the product of the charges and inversely proportional to the square of the distance between them.

Goerges Leclanche. Born 1839, Paris. Died Sept. 14, 1882, Paris. French engineer who in about 1866 invented the battery bearing his name. In slightly modified form, the Leclanche battery, now called a dry cell, is produced in great quantities and is widely used in devices such as torches and portable radios.

National Special Interest Groups

Links to VK national groups with a brief explanation of their activites. Click on the image to visit their web site.

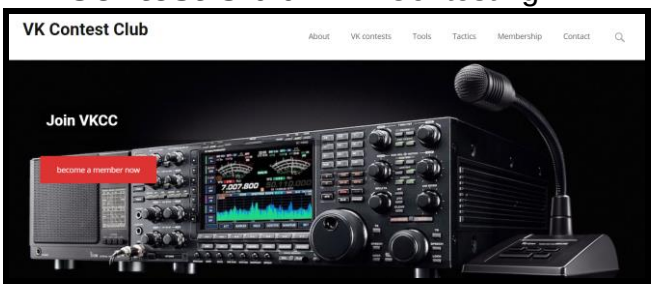
Morse code – VK/ZL site all about the code



VK QRP Club – low power operation

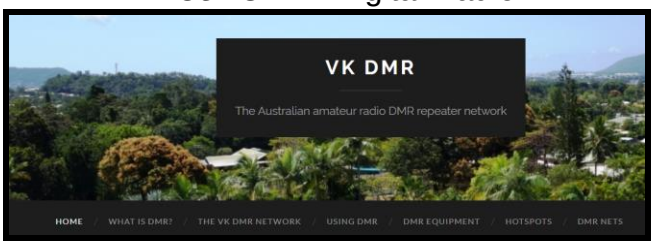
Parks n Peaks – all about operating portable

VK Contest Club – VK Contesting

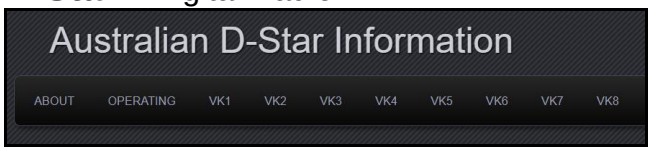


QRM Guru – resolving interference

VK Dmr Network – Digital Radio



D-Star – Digital Radio



RAOTC – for amateurs licenced 25 years or more

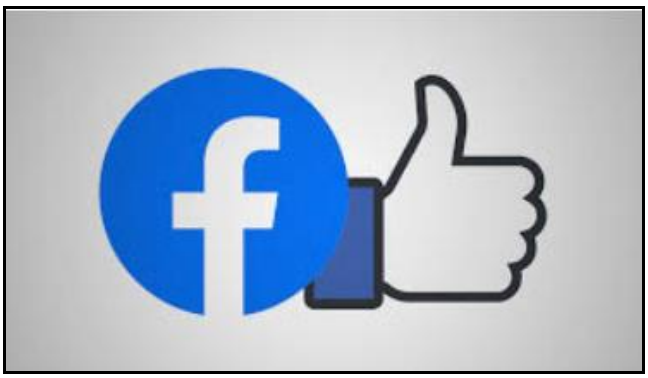
ALARA – Ladies Amateur Radio Association

If you see we've overlooked something, please send us an email editor@qtcmag.com

Social Media Resources

VK Facebook Groups

Love it or hate it, here are some links to VK Facebook groups that may be of interest.



VK Home Brew
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SOTA – portable operating – Summits on the Air
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VK DMR Network
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VK QRP Club
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QRM Guru – dealing with QRM/RFI
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Radio Amateurs Old Timers Club
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Amateur Radio Sales Australia
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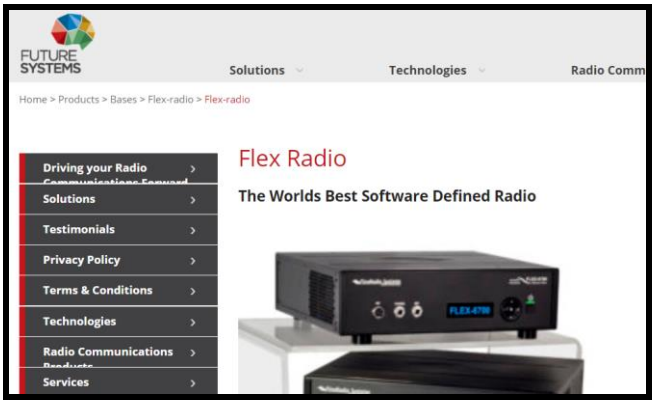

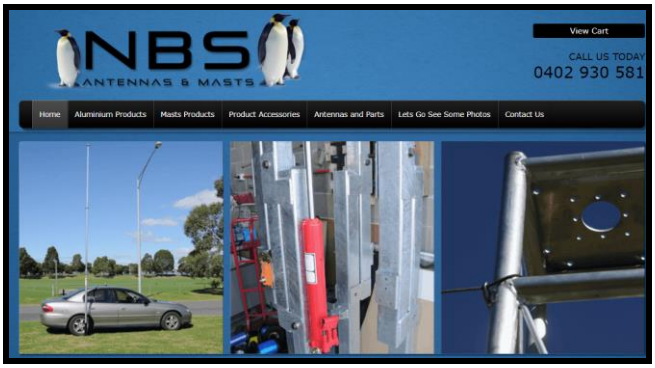

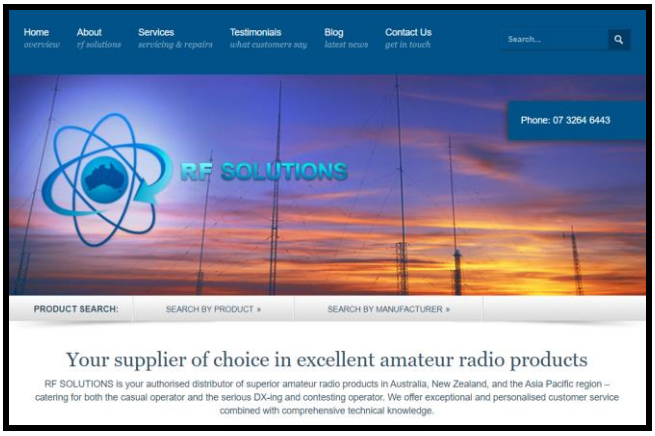

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